SCIENCE ABSTRACTS.

Section A.—PHYSICS.

APRIL 1925.

GENERAL PHYSICS.

732. *Considerations on the Specific Gravity of Crystallised Minerals and Chemical Compounds.* **U. Panichi.** (Accad. Lincei, Atti, 33. ii. pp. 182–188, Sept., 1924.)—The problem investigated is: how does the specific gravity of a simple solid body vary when it becomes part of a solid compound? The question may also be enunciated by considering instead of the specific gravity the atomic volume, which naturally varies inversely as the specific gravity, seeing that we consider their product, or atomic weight, as invariable in the simple body, whether free or in combination. The author examined theoretically a large number of crystallised compounds of which the components are also available in a crystallised form. The treatment is entirely mathematical. E. F.

733. *Standard Density and Volumetric Tables.* (Bureau of Standards, Circ. No. 19. [69 pp.] 1924.)—This circular contains standard density tables and others of a similar nature most often required in physical and chemical laboratories. For example, the density of water at all temperatures from 0° C. to 102° C.; the density of various percentages of ethyl alcohol at various temperatures; the density and pounds per gallon of milk and cream, and of American petroleum oils; temperature corrections to the indications of hydrometers in alcohol, sugar, petroleum oil, and sulphuric acid solutions. Tables are also given showing the relation between degrees Baumé and specific gravity for both heavy and light liquids; the relation of degrees A. P. I. and specific gravity; the capacities of glass vessels from the weight of water contained or delivered; and master scales for the graduation of hydrometers (alcoholometers).

734. *Density of Oxygen.* **G. P. Baxter and H. W. Starkweather.** (Nat. Acad. Sci., Proc. 10. pp. 479–483, Dec., 1924.)—Measurements of the density of oxygen prepared by four different methods and carefully purified have given results more consistent than any of those previously obtained. For electrolytic oxygen, the mean value of the density from three series of experiments is 1·42902, whereas three other series of measurements on oxygen prepared either electrolytically or from potassium chlorate or permanganate and subsequently liquefied and fractionally distilled, gave the mean value 1·42901. Taking the latter as the general mean and the coefficient of deviation from Boyle's law per atmosphere, − 0·00097, the limiting value of the molal volume of oxygen calculated to standard conditions becomes 22·415 litres. T. H. P.

735. *A Modified Spherometer.* **H. S. Rowell.** (Journ. Sci. Instruments, 1. pp. 17–20, Oct., 1924.)—An inherent lever in the spherometer is utilised to magnify the readings obtainable. This is done by making one outer leg micrometric while the other three are fixed. In most cases curvature in a plane is all that need be measured, and the same leverage principle is applied to what may be termed a cylindrometer. It is suggested that a unit of curvature is desirable, and a number of words are offered in a tentative way for consideration and possibly discussion. AUTHOR.

736. *An Automatic and Continuous Recording Balance.* (*The Odén-Keen Balance.*) **J. R. H. Coutts, E. M. Crowther, B. A. Keen, S. Odén.** (Roy. Soc., Proc. 106. pp. 33–51, July 1, 1924.)—This is a development from the original self-recording balance devised in 1915 by S. Odén. In that the record was obtained by an automatic registration of the time of release of small steel spheres, discharged one by one into a pan of the balance each time the weight of the substance being experimented on had changed by an amount equal to the weight of a sphere (the smallest which can be used in practice being one of 0·0153 gm.). The apparatus described in the present paper is an improvement on the above, giving greater detail and accuracy. An electromagnetic control is used, and so a continuous record is substituted for the discontinuous one of the earlier apparatus, but it has been found an advantage to retain the ball-dropping device, the electromagnetic control simply supplying the continuous history of the changing weight between the release of each metal sphere. The alternative was electromagnetic control over the whole range, the chart being split up (to secure sufficiently open scale) by some arrangement of counter (or "setting up" currents) increased by an appropriate amount after each transit of the chart. But this demanded currents of considerable strength to balance a comparatively small increase in weight. The chosen method is one in which the ball-dropping can proceed up to the maximum load the balance can carry. The maximum current is no greater than the equivalent of the weight of one sphere, and the sensitivity is approximately constant throughout the range for a given set of balls. It can also be varied as desired. The balance is a short beam Oertling analytical balance to carry 100 gm. The electromagnetic control is effected by a magnet, suspended from one pan of the balance, dipping into a solenoid the current through which is automatically adjusted so that the pull always balances the changing weight of the substance under observation. A continuous record of current strength thus gives a continuous record of the weight of the substance.

Besides a complete discussion of the instrument, illustrations are given of applications to the study of sedimentation and flocculation of soil particles, and the evaporation of water from fibres. M. A. G.

737. *The Theory of a Bourdon Tube Pressure Gauge and an Improvement in its Mechanism.* **C. Sunatani.** (Tohoku Univ., Technol.

Reports, 4. 2. pp. 19–60, 1924. In English.)—Though the outline of the principle of a Bourdon tube is already well known, the mode of the displacement of its free end does not yet seem to have been fully investigated, and, an unsuitable mechanism having been adopted, the graduation of the dial plate of the pressure gauge using the tube is usually not uniform. In the present paper the writer considers that the displacement of the free end should be proportional to the pressure in the tube and have very nearly a straight line motion. This consideration is proved both mathematically and experimentally, and a simple formula is deduced for the determination of the direction of the displacement. Using this formula, the writer has suitably improved the mechanism of a Bourdon tube pressure gauge and shows by experiment that the indicating needle of the improved gauge moves with great accuracy proportionally to the pressure in the tube. The strength of a Bourdon tube is also treated in this paper. AUTHOR.

738. *High-Vacuum Pumps.* **H. Ebert.** (Zeits. Instrumentenk. 44. pp. 497–500, Nov., 1924.)—A discussion of different models. [See Abstract 717 (1924).] Details of comparisons to be given later. A. D.

739. *The Extreme Vacuum Pump and the Adsorption Manometer.* **M. A. Schirmann.** (Phys. Zeits. 25. pp. 631–635; Disc., 635, Dec. 1, 1924. Paper read before the Deut. Naturforscher u. Ärzte, Innsbruck, 1924.)—Ordinary high vacuum pumps are limited by their velocity of "suction," which in the best cases is 3 to 7 litres per second. Steel pumps are excluded from consideration for directly obtaining extreme vacua, since the metal constantly diffuses and gives out gas, particularly at high temperatures. The authoress has constructed extreme vacuum pumps of glass or quartz, which have suction velocities of at least 20 to 30 litres per second. This velocity depends on the large communication surface between the fore vacuum and the high vacuum; this surface is about 100 cm.^{2} in the new pumps as against 0·1 to 1 cm.^{2} in older forms, so that the gas molecules are carried with enormous rapidity from the high to the fore vacuum. The pressure in the fore vacuum must not be more than 0·5 mm. Hg. The pump has also been constructed to give a fore vacuum of 0·01 and 0·001 mm. Hg, when still larger suction velocities (about 40 litres per sec.) have been obtained. Several such pumps can be put in parallel, and over 100 litres per sec. obtained; using in addition absorption materials and liquid air, extreme vacua of 10^{-12} to 10^{-15} mm. Hg can easily be produced. In order to maintain these extreme vacua the authoress has devised a method for removing the last traces of gas from the materials of the apparatus; discharges without internal electrodes are made use of, alternating currents of high frequency being employed, with external electrodes or external coils producing alternating fields inside the apparatus; this produces a powerful ionic or electronic bombardment of the materials in the interior, which seems to drive out the gas mainly mechanically and without much heating. The action of the adsorption or absorption manometer depends on the effect of the residual gas in the vacuum on the electronic emission of an incandescent kathode. The electronic current is $i = Cp$ where C is a constant, which can be determined at pressures p which can be measured with a McLeod manometer; it is assumed that the relation still holds in extreme vacua, and in this way, by measuring i, the pressure can be measured. In the *Discussion*, **Gaede** expressed a doubt whether the suction velocity was as great as was claimed, in the pump exhibited, and the authoress replied to his criticism. H. N. A.

740. *Theory of the Air-Lift Pump, with Special Reference to the Slip of Air Bubbles in Water.* **O. Miyagi.** (Tohoku Univ., Technol. Reports, 4. 2. pp. 1–18, 1924. In English.)

741. *The Surface Tension of Dilute Electrolyte Solutions.* **C. Wagner.** (Phys. Zeits. 25. pp. 474–477, Oct. 1, 1924.)—On the basis of the electrostatic forces to which a charge in the neighbourhood of the bounding surfaces of two dielectrics is subjected, a calculation is made of the concentration changes which occur at the surface of an electrolyte solution, and from this the increase of surface tension of water by the addition of electrolyte is deduced. The values calculated for different concentrations are found to be in agreement with those determined experimentally. [See Abstract 1784 (1910).] J. N. P.

742. *Ring Method of Measuring Surface Tension.* **P. E. Klopsteg.** (Science, 60. pp. 319–320, Oct. 3, 1924.)—The author points out that the values given for the surface tension of water measured by the ring method are on the average 3·2 dynes per cm. greater than the mean value given by other methods. Fahrenwald's explanation of this difference is discussed, and shown to be probably incorrect. The author considers that the error was probably a systematic one, due to some faulty technique, and the following explanation is suggested: As the ring is drawn out of the liquid the upward force on the ring, measured by the torsion of the wire, is just balanced by the weight of the liquid elevated above the normal surface. It is important to note that the scale readings of the instrument are taken with reference to the scale zero, and that the scale zero corresponds with the actual zero of torsion only when the arm which carries the ring is in its position of zero balance. As the ring is pulled higher with increasing force, the true zero on the scale, with reference to which reading should be taken, shifts upward from the scale zero by an amount which corresponds to the position of the arm. Consequently, at the instant the film ruptures, the scale reading will be too high. A new technique has been devised whereby the vessel containing the liquid is gradually lowered, by means of the screw adjustment on the support, while the increasing force is being applied, all the while maintaining the arm in its position of zero balance. Experiments to test this explanation have shown a difference of 3·3 dynes per cm. for water when the old technique and the new technique, respectively, were employed. F. S. B.

743. *Chemistry of Lubrication.* **W. F. Seyer and S. R. McDougall.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 35–48, 1924.)—This paper describes a series of experiments on the lubricating properties of various liquids, with a view to determining the effect of chemical structure on "boundary lubrication." The method and apparatus used was essentially the same as described by Hardy and Doubleday [see Abstract 249 (1923)]. It is shown that fatty acids and other oxygen containing substances when added to a mineral oil will improve its character as a lubricant. Various commercial oils are dealt with before and after treatment with SO_2. The effect of the solution of oleic acid, stearic acid, palmitic acid, cetyl alcohol, cetene, naphthalene, turpentine, and other substances in petrolatum was investigated. Petrolatum is a mineral oil sold by the National Drug Co., and apparently composed entirely of hydrocarbons of the C_nN_{2n} series. F. S. B.

744. *Surface Reactions in Flotation.* **A. W. Fahrenwald.** (Am. Inst. Mining Eng., Trans. 70. pp. 647–736; Disc., 737–739, 1924.)—The modern theories of the structure of matter in relation to the theory of flotation are discussed, and the latest form of the author's apparatus for measuring surface tension by the formation of films is described. With regard to the effect of various gases on the surface tension of water, little agreement exists between different investigators, owing either to experimental error or to surface contamination, or to both. If proper experimental precautions are taken, the surface tension of water, as determined by the film method, remains constant with age up to 48 hours, but it seems almost impossible to maintain absolutely uncontaminated surfaces for any length of time.

Flotation oil-water emulsions in low concentrations have constant surface tension values, these being reached after several hours, or more rapidly if the emulsion is kept gently circulating. Substances with no polar or active groups in the molecules, such as benzene or paraffin oil, are of no value as pure substances in modern flotation methods, and only substances able to spread on water have been successfully used in flotation. The effects of a number of compounds on the surface tension of water are described. The reactions occurring at the surface of contact between water and other liquids (oils) completely insoluble, or only partly soluble in it, are considered from the point of view of interfacial tension, it being assumed that adsorption of a substance or substances in the interface is always accompanied by a change in the value of the interfacial tension. The oil-collecting properties of the various common minerals met with in the flotation process are also discussed. From a predetermined surface tension-concentration curve of the substance to be tested and a knowledge of the total mineral surface, the amount of oil collected by the mineral per unit of area may be calculated with close approximation and is found to be between 10 and 100 molecules in thickness, increasing with increase in the concentration of the oil. The normal order of minerals in their oil-collecting capacity may be altered entirely by the presence of a small amount of an electrolyte. T. H. P.

745. *Gas Flows through a Capillary Tube and Reynolds' Criterion.* **J. Satterly.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 261–268, 1924.)—The author has carried out a series of experiments on the flow of air through a capillary tube over a large range of pressures and for temperatures between − 79° C. and 100° C. The curvature of the pressure-volume curves is most pronounced in the neighbourhood of volumes corresponding with the critical velocity as determined from assumed values of the viscosity at different temperatures. A. W. L.

746. *Viscosity of Ethyl Ether near Critical Point.* **A. L. Clark.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 329–338, 1924.)—Experiments were made to determine the viscosity of ethyl ether near its critical point. The logarithmic decrement of torsional oscillations was observed for a number of temperatures, starting with the critical temperature or below it, and running up to temperatures well above the critical temperature. The ether was very carefully purified by repeated washing with sulphuric acid, potassium permanganate and water, until the resulting liquid was free from alcohol, when it was dried over phosphorus pentoxide and distilled after crystallisation in liquid air. The viscosity was determined in a specially designed apparatus which consisted of a U-tube containing a gold cylinder and a stirring device. The results show that stirring affects the values obtained for the logarithmic decrement. On the whole the results obtained support the classical theory of Andrews. F. J. B.

747. *Elasticity.* **J. Czochralski.** (Zeits. f. Metallkunde, 18. pp. 457–461, Dec., 1924.)—The paper is an extension of the questions of elasticity raised in a discussion on the paper by the author on the elastic limit as a fundamental limit for calculations in constructional work. F. J. B.

748. *Elastic After-working, Hysteresis, and Internal Friction.* **H. Jordan.** (Phys. Zeits. 25. pp. 579–584, Nov. 15, 1924.)—Remarks upon a paper by K. Bennewitz [see Abstract 1 (1925)]. The logarithmic formula, to which the formula given in the abstract leads in the case of a constant force, is criticised, since it cannot hold good indefinitely. It is also pointed out that after-working and hysteresis are *not* the same thing. After-working is probably due to recrystallisation. The phenomena for cast iron and aluminium differ. There is need for further work on the subject.

W. G. B.

749. *On the Tension and Elastic Deformation of Non-planar Membranes.* **M. Lagally.** (Zeits. Math. u. Mechanik, 4. pp. 377–383, Oct., 1924.)—For the investigation of the state of tension of non-planar membranes and of sheets of small resistance to bending, a system of equilibrium conditions are employed similar to those derived by Beltrami and Lecornu for inextensible surfaces, the latter having been shown valid for extensible surfaces by Caldonazzo. In the present mathematical paper a method has been developed which bases the equilibrium problem for any surface upon a single characteristic differential equation, analogous to that adopted by Weingarten for the geometrical problem of slight surface bending. Previous work by Blaschke on the relationship between surface deformation and the possible states of tension is referred to. The first part of the paper gives the analytical determination of the force scheme involving the elastic tensions, distortions, and displacements. A second differential equation is then derived and integrated which stands in close connection with the characteristic equation, and from which a family of surfaces follow. The latter by suitable selection enable a comprehensive consideration of the statical and kinematical problems involved. The essential differences between the present and the planar problems are pointed out.

H. H. Ho.

750. *Materials under Repeatedly Reversed Stresses.* **L. Jannin.** (Rev. de Mét. 12. pp. 742–749, Dec., 1924.)—Description of the apparatus, the test pieces used (of soft steel and chrome-nickel steel) and microphotographs of the ruptures obtained. E. H. B.

751. *On the Sliding and Dividing Surfaces of the Equilibrium States of Plastic Bodies, and the Elastic After-effects of Deformed Bodies.* **A.**

Nádai. (Zeits. f. Physik, 30. 2. pp. 106–138, 1924.)—The components of strain and the sliding surfaces for some equilibrium conditions of completely plastic bodies are obtained, and also the slow movements of bodies in the plastic state such as the flowing process for ductile metals. It is shown that where the sliding surfaces possess a protecting layer or if a part, at least, from a system of equivalent sliding surfaces has a protecting layer, this layer will form a dividing surface of the two states of strain. For both regions the protecting layer forms a natural limit of the plastic bodies. It is difficult to obtain the mechanical conditions for the limiting states of strain before a plastic condition sets in or fracture results, particularly where a mixture is dealt with, and yielding occurs at the small joints of different components of the mixture. It is, however, possible to devise an explanation of the elastic after-effects of plastic deformation in certain important cases where a pronounced elastic region exists for these changes of shape. This is the case with pure iron which behaves as an elastic body, provided the elastic limits are not exceeded. An attempt is made to obtain a mechanical model of these conditions. Illustrations are shown which bear out the theory of figures of flow formed (1) in plates and tubes of ingot iron under the influence of a symmetrical radial stress, (2) cylinders and prisms of marble and sandstone compressed axially, and (3) cylinders, prisms and cubes of paraffin wax. R. S. R.

752. *Equations of State of the Plastic Phase of a Natural Isotropic Solid.* **M. Brillouin.** (Comptes Rendus, 179. pp. 1563–1566, Dec. 29, 1924.)—The solids commonly termed malleable or ductile present two phases according to the forces exerted upon them, *viz.* an elastic one with sensibly reversible properties, and a plastic phase. The author now develops a theory for the latter analogous to the theory of elasticity. He questions the validity of the isotropic theory and substitutes one which is in best accord with observations, *viz.* that the plastic phase is characterised by the fact that only one of the six elements of deformation is free to increase indefinitely, while the other five continue to be determined by elastic conditions. If the unique deformation does not produce a change of density, the phase is plastic, otherwise it is brittle. Based on this hypothesis, equations of state are derived which characterise the plastic state and rectify the equations of Levy derived from the old hypothesis. H. H. Ho.

753. *Effect of Free Surfaces on the Plastic Deformation of Metals.* **F. C. Thompson** and **W. E. W. Millington.** (Iron and Steel Inst., J. 110. pp. 61–74; Disc., 75–84, 1924.)—The authors have previously suggested [see Abstract 1278 B (1924)] that the type of deformation in a single crystal should be different from that in a fine-grained aggregate, and now develop this idea, and further suggest that at the free surfaces of even an aggregate, the deformation will probably differ distinctly from that within the mass. Evidence is given to show that the elastic limit is reached at a relatively low stress at the surface, such evidence including the difference in sizes of surface and internal crystals after subjecting certain metals to a definite tensile strain followed by a prescribed annealing. The differences of the stresses at which slip-bands are first formed on metals under test, and the elastic limits of the same metals as determined mechanically, are also given. It is pointed out that if elastic failure does occur initially at free surfaces, it should be possible to show that as the cross section of the specimen is reduced and the relative area of surface increased, the elastic limit falls, and many published tests are given in support of this. Other evidence is given that where the surface is enabled to move, plastic deformation may there be obtained under stresses far below those normally considered to be the elastic limit. It is concluded that what was determined in these tests was that stress at which movement, "easy-glide" in the non-ferrous metals or rhombic dodecahedral movement in iron took place on the surface, which bears no relationship to the stress at which elastic failure would result in the metal as a whole. The bearing of the above to fatigue testing is dealt with, and it is suggested that under all stresses, and especially in compression, the effect of free surfaces is of vital importance in connection with elastic failure.

C. O. B.

754. *Volume Change of Elastic Body.* **G. Masing.** (Zeits. techn. Physik, 5. 10. pp. 430–433, 1924.)—A mathematical deduction on the basis of the principle of virtual work, by which is obtained a relation between volume change and impressed forces. E. H. B.

755. *The Photo-Elastic Constants of Glass as Affected by High Temperatures and by Lapse of Time.* **F. C. Harris.** (Roy. Soc., Proc. 106. pp. 718–723, Dec. 1, 1924.)—Filon [see Abstract 1375 (1914)] has previously experimented on the effect of temperature on the photo-elastic constants of glass by the flexure method, enclosing the specimen in a steam jacket giving a max. temp. of 90° C. He observed a small increase in the stress-optical coefficient for the ray polarised perpendicularly to the line of stress. The present series of experiments now described were carried out with the object of extending the observations for temperatures up to near the melting-point. The specimens consisted of small blocks of glass—4 × 3 × 1 cm.—and full experimental details are included. The specimen was observed through a Nicol's prism and a Babinet compensator in the light from a sodium flame polarised by reflection at a single glass plate. With the exception of one glass, which shows a decrease—an extra dense flint containing 64·4 per cent. of PbO—the stress-optical coefficient shows an increase with rise of temperature. This exception is in accordance with previous observations that the presence of large quantities of PbO tends to reverse all the known stress-optical properties. In every case examined the value of the stress-optical coefficient has increased with lapse of time.

H. H. Ho.

756. *Relationship between Tensile Strength, Temperature and Cold-Work in Some Pure Metals and Solid Solutions.* **D. H. Ingall.** (Inst. of Metals, J. 32. pp. 41–64; Disc., 64–71, 1924.)—A continuance of work previously reported on copper wire [see Abstract 1374 (1924)], but extended to embrace silver, aluminium, nickel, 70 : 30 brass and 80 : 20 cupro-nickel. Specimens of the five materials were examined in the soft annealed state, and after cold-work by drawing, representing 25, 50 and 75 % reduction of cross-sectional area. The constant load and rising temperature method of experiment was used; in each test a definite load was applied to the wire and maintained while the wire was heated in a resistance tube furnace at the rate of 20° per min. till it broke. Certain properties are found to be common to all these metals investigated; for instance, a fundamental relationship with regard to tensile strength and temperature, which is expressed by a straight line up to a critical inflection temperature and by a curved line for higher temperatures. There appears to be a close connection between the percentage general reduction curves, the percentage contraction of area curves, and the corresponding tensile strength curves. During the testing some of the wires developed a noise like a kettle "singing." This only occurred in wires which actually broke at temperatures beyond the critical temperature. In addition to these common properties, there are some results peculiar to each individual material. The straight line or lower temperature curves mentioned above will change direction at the temperature at which any allotropic or phase change may take place. The critical inflection temperature of the whole material will be that of the constituent with the lowest individual critical inflection temperature. The curved line or higher temperature curve may exist in two (or possibly more) portions. C. O. B.

757. *Effects of Iron on Copper.* **D. Hanson** and **(Miss) G. W. Ford.** (Inst. of Metals, J. 32. pp. 335–361; Disc., 361–365, 1924.)—This constitutes Part II of the investigation of the effects of impurities on copper carried out for the British Non-Ferrous Metals Research. The results indicate that iron exerts a considerable effect on the properties of pure copper—in fact, very much greater than that of oxygen. The observed effects on the mechanical, electrical and other properties are in keeping with the structure and constitution as revealed by the miscroscope. Solid copper will dissolve about 4 % iron at 1100° C., but the solubility at lower temperatures is much less. The electrical resistivity increases rapidly as the iron content is raised. When the iron content exceeds 0·2, the effect on the resistivity depends largely on the heat-treatment. The effect of iron on the tensile strength is comparatively small, the effect of 2 % iron being to raise the tensile strength from 14·5 to about 20 tons per sq. in. The effect of heat-treatment on the strength of copper containing iron is relatively small. Iron has no great embrittling effect, and copper containing iron can be rolled with ease. Iron is a deoxidiser for copper, but it creates difficulties during casting, owing to the formation of films that destroy the continuity of the metal. The deoxidising action is not great, as a considerable excess of iron would appear to be required to remove all the oxygen. Copper containing iron as a sole impurity is difficult to machine; it is soft, and "drags" under the tool. C. O. B.

758. *Method for Measuring Internal Stress in Brass Tubes.* **R. J. Anderson** and **E. G. Fahlman.** (Inst. of Metals, J. 32. pp. 367–379; Disc., 379–383, 1924.)—The usual accelerating cracking agents were found to be of no value in detecting the presence of stress in certain lots of brass tubing with a cold reduction in area from 17 to 56 %. It does not follow that the material is free from internal stress because a wrought brass does not crack under the application of an accelerating cracking agent. In the tubing under examination, machining by Heyn's method failed to show length changes—that is, failed to disclose the presence of stress. Cutting diametral rings also failed to show evidence of circumferential stress. The stresses in some drawn brass tubes are shown to be only longitudinal tensile and compressive stresses, and a method, called the strip method, has been developed for detecting the presence of longitudinal internal stress and for measuring quantitatively such stress in drawn brass tubes. The method consists in slitting a narrow strip 2·75 in. long and 0·10 in. wide in a 3·25 in. length, releasing one narrow end only in the cutting; longitudinal stress is indicated by the springing out of the strip. The amount of stress can be calculated from the amount of spring and the elastic modulus of the material of the tube. This method can be applied in determining the laws governing the release of longitudinal stress in cold-drawn tubes on heat-treatment. [See also Abstract 2420 (1924).] C. O. B.

759. *The Breaking Strain of Bent Rods under Elastic Tensions.* **H. Zimmermann.** (Preuss. Akad. Wiss. Berlin, Ber. 26. pp. 277–288, 1924.)—Previous work is briefly referred to, the object of this publication being the evaluation of the breaking strain of a rod bent by elastic forces at both ends. As initial form of the rod axis the cosine equation $y = y_0 \cos \pi(x_m/l + x/l)$ has again been adopted, y_0 being the vertical height, l the wave-length, and x_m the vertical displacement with respect to the centre of the rod chord. § 1 investigates the elastic changes in the bent rod without tension, and § 2 the breaking strain with elastic tensions at the extremities. The paper is mathematical throughout, and it is remarked that rods under tension with freely movable ends seldom occur under structural conditions, the connections between neighbouring rods acting more or less as elastic tensions, while the rods themselves are never entirely straight. The present investigation should therefore possess utilitarian value. H. H. Ho.

760. *Symmetrical Axial Deformation of Rotating Bodies.* **A. Timpe.** (Zeits. Math. u. Mechanik, 4. pp. 361–376, Oct., 1924.)—Reference is briefly made to previous work by A. and L. Föppl, Wangerin, Michell, Love, and Serini, preliminary to an investigation of suitable fundamental expressions in cartesian and curvilinear coordinates for the symmetrical axial deformation of rotating bodies. Results of an earlier publication on the torsion of rotating bodies [Math. Ann. 71. p. 480, 1911] and of Serini's investigations are utilised. Applications are given for circular and annular plates, which bodies have proved very suitable for the purpose of a critical consideration of the basis and consequences of the theory and for the cylinder and spheroid. In the paper, which is entirely mathematical, § 1 derives the elasticity equations in cylindrical coordinates, § 2 considers the solid cylinder and circular plate, § 3 the hollow cylinder and annular plate, while § 4 deals with the application of curvilinear coordinates and the spheroid. H. H. Ho.

761. *Elastic Vibrations in Force-Free Flowing Ether.* **O. Wiener.** (Phys. Zeits. 25. pp. 552–559, Nov. 1, 1924. Paper read before the Deut. Naturforscher. u. Ärzte, Innsbruck, 1924.)—A mathematical paper whose importance lies in its proof that this supposed flowing ether is capable of vibrations of an elastic type. E. H. B.

762. *New Researches upon Turbulence.* **L. Schiller.** (Phys. Zeits. 25. pp. 541–544, Nov. 1, 1924. Paper read before the Deut. Naturforscher u. Ärzte, Innsbruck, 1924.)—After pointing out that the dimensional formula for the resistance to fluid flow in tubes does not, as usually employed, contain the distance of the point of observation from entry (length of tube), gives results showing that, as the length of tube increases from 160 to 2000 radii, the "critical number" decreases from about 10^4 to the more usually adopted value of 1200. That there is a transition period, in which the laminar motion breaks down gradually, is further borne out by diagrams showing the dependence of the resistance coefficient upon Reynolds' number for various lengths of tube the sudden increase consequent upon the entry of turbulence occurring at much higher Reynolds' number in the shorter tubes. [See Abstracts 1225 and 2048 (1922).] W. G. B.

763. *Some Problems of Two-Dimensional Hydrodynamics.* **Dorothy M. Wrinch.** (Phil. Mag. 48. pp. 1089–1104, Dec., 1924.)—This mathematical paper treats the motion of a cylinder in fluid when the curve of cross-section of the cylinder is a member of the series of curves given by the equations

$$x = a\cos u + \tfrac{1}{2}b\cos 2u \qquad 0 < b < a$$
$$y = b\sin u - \tfrac{1}{2}b\sin 2u$$

which has been selected because it comprises curves with concave and convex arcs and cusps of a type not hitherto subjected to exact mathematical analysis. The problems discussed comprise the motion (1) of a fluid streaming past such a cylinder with uniform velocity, (2) when the cylinder moves with uniform translational velocity in a fluid at rest at a great distance, (3) when the cylinder rotates with uniform angular velocity about its axis in a fluid at rest at a great distance, and (4) when there is circulation of the fluid round the cylinder. Various combinations of the pure types are also worked out which are applicable to aerofoils of high aspect ratio when the various constants involved are so chosen that the velocity is sufficiently small. H. H. Ho.

764. *On a Boundary Problem in Hydrodynamics.* **C. W. Oseen.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. 17. [5 pp.], 1924.)—Entirely mathematical. E. F.

765. *A Further Contribution to the Theory of Anisotropic Liquids.* **C. W. Oseen.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. 13. [36 pp.], 1924. In German.)—This paper deals with the laws of the propagation of light through anisotropic liquids, supplementing the author's previous publications [see Abstract 1675 (1924)]. Maguin having dealt only with the propagation of a plane light wave along the axis of a helicoidal structure, the present investigation attempts its generalisation. Although Maguin's special problem admits of an exact solution, the general case can only be dealt with by approximation methods, which are set forth in § 1. While these are applicable to non- as well as to homogeneous isotropic liquids, the general formulæ are invalid when the liquid is isotropic and non-homogeneous. If damping be absent, then no rotation occurs of the plane of polarisation. § 2 introduces the assumption that the molecules possess rotational symmetry about an axis, and § 3 considers the simplest case of isotropic molecules with respect to magnetic permeability which do not rotate the plane of polarisation. The result found is that the oscillation directions of the electric and magnetic vectors possess no inertia in an anisotropic medium. § 4 examines the propagation of a plane light wave parallel to the axis of a helicoidal structure. For the case where the molecular axes are parallel to the boundary planes, the Maguin formulæ are obtained. § 5 shows that the approximate solution is sufficiently general to determine the boundary conditions. § 6 deals with the passage of rays in a structure where the orientation of the molecule only depends on one variable, and the problem can be solved in elliptic functions. § 7 gives the most important formulæ for the case where the molecules rotate the plane of polarisation. § 8 deals with the limitations involved in the assumption that all molecules are equally directed for one wave-length. Friedel's result that for bodies of the cholesterine type a circularly polarised wave, which is weakened by reflection at the under boundary plane of a layer, gives a wave at exit from the upper layer whose circular polarisation is in the same sense as that of the reflected wave, is found inexplicable on the above simple assumption, but in § 9 finds an explanation on the assumption that the molecules within the layer are so placed that the orientation at the upper is exactly opposite to that at the under boundary plane. The treatment is entirely mathematical. H. H. Ho.

766. *New Theory of Fluid Flow.* **A. B. Cox.** (Frank. Inst., J. 198. pp. 769–793, Dec., 1924.)—The author develops a theory of fluid flow from a consideration of the fact that a thin film of the fluid in contact with the wall of a circular pipe, or the bottom of a channel is at rest and that the velocity of the elements of flow is greatest at or near the centre of the pipe. It is shown that the only curve that will permit of the above conditions is the logarithmic or exponential curve. The use of this comparatively simple formula is found to be justified as it fits velocity distribution curves obtained by careful experiment, regardless of whether the velocities used are above or below the critical, and also regardless of whether the fluid used is a gas or a light or heavy liquid. In conclusion the author states that the log curve permits of the derivation of fluid flow formulæ which appear to be generally applicable to all sorts of fluids, and which give results in reasonable accord with the facts. F. S. B.

767. *Molecular Rotation and the Flow of Liquids.* **H. Baudisch.** (Elek. u. Maschinenbau, 42. pp. 721–724, Dec. 14, 1924.)—An attempt is made to examine the flow of liquids, taking molecular rotation into account; the simplest possible case, that of rectilinear parallel flow, is considered, and the distribution of velocity is that due to friction against the walls, with no frictional viscosity in the liquid itself. Every section perpendicular to the direction of flow can then be considered as an energy surface, at every point of which the liquid has the same energy of motion. The liquid can be regarded as made up of minute molecular spheres, which remain spherical even at high pressures and practically of the same size. It is apparently assumed that the molecules all rotate in the same direction about axes perpendicular to the stream lines, and parallel to the wall, the angular velocity falling off from each of two parallel walls towards the centre where $\omega = 0$; at the same time the velocity of translation increases, so that the kinetic energy remains constant; in this way a differential equation is obtained, the solution of which is $v = C_1 \sin (C_2 + 2x\sqrt{M/I})$, $\omega = C_1\sqrt{M/I} \times \cos (C_2 + 2x\sqrt{M/I})$, where M is the mass of a molecule, I the moment of inertia about a central axis, x is the distance from the wall, and C_1 and C_2 are integration constants; C_1 is equal to the maximum value of v, midway between the walls; C_2 is shown to lie between the limits $\pi/2$ for perfectly smooth and 0 for perfectly rough walls. The case of a cylindrical tube is also considered. H. N. A.

768. *The Influence of the Degree of Instability on the Phenomena of Round Liquid Columns.* **R. A. Castleman, Jr.** (Nature, 114. pp. 857–858, Dec. 13, 1924.)—Plateau's criterion of instability—*viz.* when the wave-length is greater than the circumstance—is first briefly noticed and followed by a reference to Rayleigh's recognition that the question whether or not an actual jet breaks up in the allotted time depends also on the time-rate of its collapse, and thus on physical and geometrical properties of the jet other than its surface tension. The present note furnishes illustrations of phenomena that depend on this consideration for their explanation, and puts factors on which the time-rate depends (deduced by Rayleigh) into more convenient form for study. The writer summarises dynamic cases into the question: Has the instability a chance to produce its effect before something else happens? H. H. Ho.

769. *On the Motion of Spheres, Circular and Elliptic Cylinders through Viscous Liquid.* **W. J. Harrison.** (Cambridge Phil. Soc., Proc. 23. pp. 71–88, Nov., 1924.)

770. *Irrotational Waves in Deep Water.* **T. Levi-Civita.** (Accad. Lincei, Atti, 33. ii. pp. 141–150, Sept., 1924.)—An account of a vigorous mathematical determination to appear in the "Mathematische Annalen." A. D.

771. *Fluid Motion.* **B. Finzi.** (Accad. Lincei, Atti, 33. i. pp. 495–499, June 15, 1924.)—That type considered in which, at any point P, the velocity, the vortex, and the vector from a point 0 fixed in space are all co-planar, so that $r\{v \wedge \text{curl}\, v\} = 0$. The condition of integrability is $\text{curl}\, \{v \wedge \text{curl}\, v\} = 0$ when the motion is stationary and is due to a velocity-potential. On integration we have Eulerian formulæ; and the integral gives, for a pressure p, a relation which constitutes an extension of Bernoulli's theorem of irrotational movement. A general solution of the problem is found, depending on the composition of two particular movements. A. D.

[**772.** *Measurements of Aerodynamic Force on Aeroplanes.* **E. Huguenard, A. Magnan** and **A. Planiol.** (Comptes Rendus, 179. pp. 1246–1248, Dec. 1, 1924.)—Describes an apparatus for measuring the actual deflections of the wings of an aeroplane in flight. A piston connected to a point on the wing moves in a cylinder rigidly connected to the body. The interior of the cylinder is connected by copper pipe to another smaller cylinder, which has a piston actuating a needle and recording apparatus, the cylinders and tube being filled with liquid. Traces obtained with the new apparatus, and simultaneous ones obtained from the recording dynamometer previously described [see Abstract 748 (1924)] for a full-size aeroplane in a wind, are in so close agreement that it is suggested that the new apparatus may be used to obtain the aerodynamic forces on an aeroplane in flight. W. G. B.

773. *On the Forces which Support Aeroplanes and their Relation with Hydrodynamic Actions at a Distance.* **V. Bjerknes.** (J. de Physique et le Radium, 5. pp. 353–367, Dec., 1924).—In this paper the author develops a method for the transformation of the equations of motion of a continuous body. This transformation is applicable whatever be the form of the internal tensions (fluid or solid), and enables an analogy with the equations of the electromagnetic field to be established. At each phase of the motion the hydrodynamic field presents a structure geometrically identical with that of a stationary electric or magnetic field, and exerts forces equal but of contrary sign to the forces of this field. Different examples of the analogy are presented, *e.g.* rotating spheres and cylinders with doublets and electric currents. The force supporting an aeroplane wing is explained by the vortex which develops under the wing. This vortex set in the general air current exerts a similar force to that produced by a magnetic field upon an electric current. The analogy is verified experimentally and found to be the basis of the theories of Lanchester and Prandtl. Experimental details with illustrations are included. H. H. Ho.

774. *Vortex Sheets and Circulation.* **W. Müller.** (Zeits. techn. Physik, 5. 10. pp. 450–458, 1924.)—A mathematical paper which applies previously derived theorems to the problem of the determination of the vortex motion at the edge of a Joukowsky wing profile. The comparison with experiment leads to various considerations on the mechanism of the vortex and circulation formations by moving wings. E. H. B.

775. *Law of Resistance to Spherical Particles in a Gas.* **J. Mattauch.** (Phys. Zeits. 25. pp. 620–623; Disc., 623–624, Dec. 1, 1924. Paper read before the Deut. Naturforscher u. Ärtze, Innsbruck, 1924.)—Following Ehrenhaft, the author determines experimentally the law of resistance to the motion of spherical particles of oil in nitrogen and carbonic acid gas at different pressures, without any assumption as to the electrical constitution of the atom, and results are obtained agreeing closely with those of Millikan. The charge on the particle is found to be $4{\cdot}709 \times 10^{-10}$ e.s.u. In the *Discussion* Ehrenhaft's views as to the divisibility of the electron do not agree with those of Millikan. [See Abstracts 1714 (1923) and 2819 (1924).] G. E. A.

776. *Newtonian Mechanics and Light Quanta.* **K. Schaposchnikow.** (Zeits. f. Physik, 30. 3. pp. 228–230, 1924.)—From Newtonian mechanics in connection with the inertia principle of energy it is given on the basis of the hypothesis of rotating light quanta that the cross-section of a quantum is equal to $\lambda^2/2\pi$ and that the impulse moment produced by a circular polarised wave in the unit of time through unit cross-section is equal to $U_0\lambda/2\pi$. From the latter, as is known, the selection rule for the orbits follows. In the present paper these points are briefly discussed. A. E. G.

777. *A Study of the Properties of Globular Distributions.* **S. D. Wicksell.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. 23. [16 pp.], 1924.)—This entirely mathematical paper considers a system of points in *n*-dimensional space, the distribution being termed globular if the density is a function only of the distance from a central point (radius vector). This function may in the general case be anything, but in this paper it is assumed to be everywhere finite and zero outside a certain limiting distance from the centre. Globular distributions in two and three dimensions are treated under the sections of circular and spherical. The prototypes of such distributions are the so-called globular clusters, agglomerations of stars in spherical layers of equal density around a common centre. The projection of such a cluster—*e.g.* on a photographic plate—forms a circular distribution, while the cluster itself forms a spherical one. A special type of globular distribution is that of Maxwell for the velocities of gas-molecules, where the log. of the inverse density is proportional to the square of the distance from the centre. H. H. Ho.

778. *Approximate Calculation of Periods of Lateral Vibrations of Rods with or without End Thrusts.* **K. Shôgenji.** (Kyushu Univ. Coll. Eng., Mem. 3. 3. pp. 143–175, 1924. In English.)—The natural fundamental period of the lateral vibrations of a rod simply supported at any number of points, the flexural rigidity and density being constant in each span, and the external loading being a uniform lateral load, with or without a constant longitudinal end thrust, is calculated by Rayleigh's approximate method of making use of a hypothetical type of vibrations. For the said type, the static deflection curve of a horizontal rod under gravity is used, and it is shown that the period computed in this way is very close to what the ordinary equation obtainable from that of motion will give. The calculation is much simplified by substituting an approximate deflection curve for a true one. A few functions necessary for calculating the period of a rod over two spans with end thrusts are tabulated and graphed. E. H. B.

779. *Applications of Virtual Work.* **K. Hayashi.** (Kyushu Univ. Coll. Eng., Mem. 3. 3. pp. 117–142, 1924. In German.)—A mathematical paper in which the principle of virtual work is applied to a number of cases of cantilevers and other beams. E. H. B.

780. *Diffusion Theory of the Positive Column.* **W. Schottky.** (Phys. Zeits. 25. pp. 635–639; Disc., 639–640, Dec. 1, 1924. Paper read before the Deut. Naturforscher. u. Ärtze, Innsbruck, 1924.)—The paper is a theoretical discussion of the diffusion in the positive column, and is not suitable for abstracting. [F. J. B.

781. *Diffusion of Hydrogen into Air, measured by the Interferometer U-Gauge.* **C. Barus.** (Nat. Acad. Sci., Proc. 10. pp. 447–452, Nov., 1924.)—The application of a slightly modified form of the interferometer U-gauge, previously described [see Abstract 1650 (1924)], to the investigation of the diffusion of hydrogen into air is described. Values of the coefficient of diffusion of hydrogen into air determined by means of the gauge are considerably greater than—being in some cases twice as large as—the commonly accepted value of this coefficient, *viz.* 0·66 at 17°. J. S. G. T.

782. *Diffusion of Mercury and Iodine Vapours through Nitrogen.* **J. M. Mullaly and H. Jacques.** (Phil. Mag. 48. pp. 1105–1122, Dec., 1924.)—Diffusion of the vapours arising from liquids or solids and passing through various gases is well known to give statistical measures of the mechanical interactions of the molecules concerned. Few elementary vapours have been investigated in this respect, because it has been difficult to experiment with substances slightly volatile. Following the speculations of Stefan in 1872, the vapours of water and of many carbon compounds were early investigated by Winkelmann in 1884. More recently (1916) le Blanc and Wuppermann have determined the rates of evaporation of similar liquids in air under more refined conditions. The present investigation is undertaken primarily as a test of an experimental method, prior to the application of this method to further problems of diffusion. For establishing the gradients of vapour concentration necessary for diffusion in a steady state along a uniform tube, advantage is taken of chemical combination between two diffusing vapours, and the consequent precipitation of both as solid products. The two vapours, of mercury and of iodine, are allowed to diffuse from the free elements situated at the opposite ends of a closed glass tube containing nitrogen. As fast as the vapours diffuse towards one another, they combine and deposit the iodides of mercury in a region of the tube where they meet. In no case is more than 0·2 mg. of nitrogen contained in a tube. For economy, therefore, also by reason of the stationary condition of the gas, the present method has advantages over those of Winkelmann and of le Blanc and Wuppermann, each of which methods requires a continued circulation of many litres of gas, at constant pressure, throughout the period of the experiment. The average ratio D_{HgN}/D_{IN} 1·78 found for the coefficients of diffusion differs but slightly from the value 1·70 obtained from the absolute determinations at low pressures. The difference is probably real, since the coefficients of diffusion may vary with the proportions in which vapour and gas are mixed. But no great stress is laid upon this difference since it is comparable with the errors of experiment. The difference is due partly to the neglect of the term C_1/C_2 in Stefan's equation (meaning that 1·70 is too small a ratio) and partly to resistance offered by the narrow tubes to the flow of iodine vapour (1·78 being thus too large). The magnitude of the mean ratio 1·74 shows that iodine diffuses more slowly than mercury. Interpolation from the direct observations gives for a temperature of 19°·4 C. $D_{HgN} = 32{\cdot}3$ when $P_N + \frac{1}{2}P_{Hg} = 3{\cdot}00$ mm. and $P_N/\frac{1}{2}P_{Hg} = 5{\cdot}0 \times 10^3$ and $D_{IN} = 5{\cdot}70$ when $P_N + \frac{1}{2}P_I = 10{\cdot}00$ mm. and $P_N/\frac{1}{2}P_I = 1{\cdot}06 \times 10^2$. Discussion of these results is postponed to a future communication.

A. E. G.

783. *Structure of Electrolytic Nickel.* **G. Wazau.** (Zeits. f. Metallkunde, 16. pp. 482–483, Dec., 1924.)—The cause of the brittleness of electrolytic nickel when worked was investigated. Microphotographs are given showing the structure of nickel as obtained by electrolysis, and after definite heat treatment and work. The hardness after heat treatment was determined, and it was found that at 600° C. a great decrease of Brinell hardness took place. At this temperature the recrystallisation of the nickel is not complete, a temperature of 900° C. being required before the structure is in equilibrium. The cause of the brittleness is ascribed to hydrogen contained by the metal.

F. J. B.

784. *Researches on Metal Crystals. III. Thermal Expansion of Zinc and Cadmium.* **E. Grüneisen and E. Goens.** (Zeits. f. Physik, 29. 3–4. pp. 141–156, 1924. From the Reichanstalt.)—Using the monocrystalline rods previously described the coefficients of expansion parallel and perpendicular to the crystalline axis were determined for a range of temperature from − 253° C. to + 100° C. The dependence upon temperature is very marked, and quite different for the two directions; the coefficient perpendicular to the axis becomes negative at low temperatures. A theoretical investigation of the dependence of the coefficients upon temperature is given, which is in very fair agreement with the observations, including the negative coefficient. [See also Abstract 2659 (1924).] W. G. B.

785. *Carbon Atom in Crystalline Structure.* **W. Bragg.** (Nature, 114. pp. 862–865, Dec. 13, 1924. Frank. Inst., J. 198. pp. 615–625, Nov., 1924.)—In a general review of the achievements of scientific research as represented by attempts to explain the properties of materials in terms of the properties of their parts, it is pointed out that, whilst the properties of gases and of liquids are to a certain extent explainable on grounds of kinetic and hydrodynamic theories respectively, little is known of the relation between the properties of solids and of their component atoms. Within the last ten years direct study of crystal structure has been rendered possible by means of X-ray analysis, and the actual arrangement of the atoms of a crystal can be studied from the point of view of its physical characteristics. The atomic structures of elementary carbon in the forms of diamond and graphite are thus found to present close agreement with the known physical and chemical properties of carbon, both as an element and in combination. The disposition of the tetrahedral atoms in the diamond shows that they may be divided into two classes, any member of one class being the reflection of the other—with appropriate shift—in any one of the three planes which are the cube faces of the crystal. In graphite, the atoms, arranged in layers separated by 3·40 Å.U., are no longer tetrahedral, and are very strongly tied to three neighbours, all in one plane; the distance between the centres is 1·44 Å.U. as compared with 1·54 Å.U. in the diamond. In calcite the carbon atom is surrounded symmetrically by three atoms of oxygen. This compact group possesses a double negative charge, the calcium atom possessing the corresponding amount of positive electricity. A similar study of the crystal structure of anthracene, naphthalene, and the fatty acids is discussed. A. B. C. L.

786. *Isomorphism of Stannous Oxide and Litharge.* **G. R. Levi.** (N. Cimento, 1. pp. 335–344, Oct.–Nov.–Dec., 1924.)—Stannous oxide exhibits tetragonal, centred-face structure, the ratio $c:a$ having the value 0·895; no cubic form of this oxide appears to exist. Red lead monoxide has a similar structure, the axial ratio being $c:a = 0\cdot 90$. The perfect isomorphism of these two oxides is thus established. T. H. P.

787. *Electrified Spherical Corpuscles. Direct Calculation of the Gravitation Constant as a Function of the Constants of Avogadro, Faraday, Rydberg, and Planck.* **L. Décombe.** (Comptes Rendus, 179. pp. 1150–1153, Nov. 24, 1924.)—This paper, which is entirely mathematical, derives the gravitation constant from the electrodynamics of charged corpuscles, and then deduces the frequency of nuclear and electronic radiation. The latter result implies a power of unlimited penetration, and classifies such in the domain of ultra-penetrating radiations to which many authors, notably Perrin, have attributed the origin of radio-activity. H. H. Ho.

788. *Mathematical Statistical Investigation of the Sub-Electron Question.* **H. Daecke.** (Phys. Zeits. 25. pp. 624–629; Disc., 629–631, Dec. 1, 1924. Paper read before the Deut. Naturforscher u. Ärzte, Innsbruck, 1924.)—The results of M. König, who has measured the charge ϵ on spheres of different diameters in air, are analysed; the author finds that when the radius is diminished below $1 \cdot 2 \times 10^{-5}$ cm. the charges sink considerably below $4 \cdot 77 \times 10^{-10}$, the electronic charge, and endeavours to find the probability that the twenty-four values obtained are whole multiples of a definite fundamental charge, the exact relation being veiled by errors of measurement. The cyclical theory of errors of R. v. Mises is made use of and it appears that there is a probability of charges $0 \cdot 251 = 4 \cdot 77/19$, $0 \cdot 53 = 4 \cdot 77/9$, $0 \cdot 6814 = 4 \cdot 77/7$, and $0 \cdot 954 = 4 \cdot 77/5$ (in each case multiplied by 10^{-10}) being the correct values of the actual charges. With CO_2 and mercury maxima of probability are found for $\epsilon = 0 \cdot 37$, $0 \cdot 59$, $0 \cdot 80$, and $1 \cdot 14 \times 10^{-10}$; using 30 values obtained by Radel, maxima are found for $\epsilon = 0 \cdot 25$–27, $0 \cdot 34$, $0 \cdot 36$–$0 \cdot 37$, $0 \cdot 45$, $0 \cdot 53$, $0 \cdot 68$, $0 \cdot 73$; while $4 \cdot 77/18 = 0 \cdot 265$, $4 \cdot 77/14 = 0 \cdot 3407$, $4 \cdot 77/13 = 0 \cdot 367$. The conclusion of the author is that the assumption that the actual charges were whole sub-multiples (with small denominators) of $4 \cdot 77$ has greater probability than any other assumption; he appears to admit that the connection of his figures with any theory of sub-electrons cannot be a direct one. H. N. A.

789. *On the Determination of Molecular Fields. III. From Crystal Measurements and Kinetic Theory Data.* **J. E. Jones.** (Roy. Soc., Proc. 106. pp. 709–718, Dec. 1, 1924.)—The investigation deals with crystals of simple and face-centred cubic structure, and expressions are worked out mathematically for the potential energy of these forms. As a result of these it is found that, using the results of K. Onnes and Crommelin, argon atoms must repel according to an inverse 50th-power law to give the atomic distance 3·84 Å. observed in the crystal, while the results of Holborn and Otto give the inverse 14th-power law; this is for the face-centred cubic structure. When crystalline argon is assumed to be of simple cubic form, the atomic distances calculated from the results of Holborn and Otto are, for all values of n, the exponent in the repulsive force law, greater than those for the face-centred structure; when, however, the potential energies are calculated for the two structures it is found that the face-centred one has less potential energy. The crystals of KCl and CaS each consist of two interpenetrating face-centred cubics, and may be regarded as simple cubic, with alternate + and − ions at the corners of the unit cube; the K and Cl ions may each have the same outer shell of electrons as argon; the outer shell of the Cl ion is probably larger than that of argon, and that of the K ion smaller; their fields will be a little different from that of argon. In the same way CaS may be regarded as a collection of argon atoms, in a simple cubic lattice, with double positive and negative charges added alternately. An expression is given for the potential energy of one atom due to all the rest, and values are tabulated for the interatomic distances for both crystals, derived from the experimental results of K. Onnes, and from those of Holborn and Otto, for various values of n; the values calculated from the viscosity are given in the same tables. From the Holborn and Otto results n lies for both substances between 14 and 21. H. N. A.

790. *Quantum Statistics of the Bohr Atom.* **M. Planck.** (Ann. d. Physik, 75. 7. pp. 673–684, Dec., 1924.)—As is known, all characteristic quantities for a given thermic condition are derivable from a single function $Z = \Sigma e^{-E/kT}$, where E is the energy in any quantumly possible condition. If we collect all those conditions, P_n, n in number, which have the same $E, = E_n$, we have $Z = \Sigma P_n e^{E_n/kT}$. In the Bohr hydrogen atom the energy $= - 2\pi^2 \mu \eta^4 / n^2 h^2$. This gives for the Z of the atom a diverging series if n be taken from 1 to ∞. The problem is how to overcome this difficulty. Methods of Bohr, Herzfeld, Becker, Fermi discussed. The author shows how to find a definite value for the Z in three portions, which are found to correspond respectively to the free energy of the isolated nucleus, to the free energy of the free electron, and to the free energy of the undissociated atom. A. D.

791. *On the Stationary Motions in Electrodynamics.* **U. Crudeli.** (Accad. Lincei, Atti, 33. ii. pp. 238–243, Oct., 1924.)—In a report to the Solvay Congress of 1921, N. Bohr remarks that we may, with very close approximation, describe the motion of particles in the stationary states of an atomic system as that of mass points moving under the influence of mutual repulsions and attractions due to their electric charges. This is still the prevailing point of view in the domain of the dynamics of molecular, atomic, and nuclear models, though the first constructions based on the Rutherford-Bohr hypothesis have been followed by others on a different basis (see Hermann, "Spectra and Atomic Structure," p. 89, 1923, and an article by Lewis, Scientia, ii. 1924.) To the concrete arguments brought forward by Bohr we must add the fact that, within the limits of a first approximation, without touching on A. Sommerfeld's researches regarding the so-called fine spectral structure, a systematic analytical study of the Rutherford-Bohr systems is wanting. As a contribution to this study the author's object is to obtain a general proposition on the systems constituted by three or more Rutherford-Bohr points in relative equilibrium. The treatment is mathematical. E. F.

792. *A Static Model for Helium.* **H. S. Allen.** (Roy. Soc. Edinburgh, Proc. 44. 2. pp. 116–128, 1923–1924.)—In a previous paper (*ibid.*, 43. 2. pp. 180–196, 1922–1923) the author has considered Langmuir's static model for the hydrogen atom, which introduced, in addition to the Coulomb attraction between electron and nucleus, a repulsive "quantum force" which produces stable equilibrium at a distance $r = A_n$ from the nucleus, where $A_n = n^2h^2/4\pi^2me^2$; m is the mass and e the charge of an electron, n an integer, and h Planck's constant, A_n is the radius of a circular orbit in Bohr's theory. A force of the type required is provided by Whittaker's quantum mechanism. The quantum force is $F = e^2A_n/r^3$ and the author supposes that it is repulsive for unlike and attractive for like charges. To ionise the normal H-atom work $W_0 = \frac{1}{2}e^2/A_1 = V_0 e$ is required, and $V_0 = 13{\cdot}48_6$ volts. Hughes's value, calculated from Rydberg's constant, is $13{\cdot}52_4$ volts. Static models of the H_2 molecule are discussed, and the work required to separate an electron and the moments of inertia are calculated. The negatively charged H atom and triatomic hydrogen are also considered. Similar methods are employed for helium. The positively charged (ionised) helium atom is first considered, the repulsion due to the quantum force is assumed equal to e^2a_n/r^3, the electrostatic attraction being $2e^2/r^2$, with stable equilibrium for $r = \frac{1}{2}a_n$; this makes the work required to remove the electron four times that required in the case of the hydrogen atom. This is the result obtained from Bohr's original theory. Both symmetrical and unsymmetrical configurations have been considered in the case of the neutral helium atom, and in some of them "half quantum" numbers have been employed; in no case does the calculated value of W quite agree with the experimental value 78·6 volts. The existence of a helium molecule is a necessary assumption for the explanation of the band spectrum by the quantum theory, since the calculated moments of inertia are too large for the helium atom; the molecule has no doubt only a transitory existence. The distance between the nuclei, the work, W, in the one quantum state and the moment of inertia have been calculated for a number of symmetrical arrangements; values obtained for the moment of inertia are of the same order of magnitude as that determined by Curtis from observations of the band spectrum. It appears that, for certain purposes, a static model may be usefully employed, owing to the comparative simplicity of the mathematics and of the physical conception involved. H. N. A.

793. *Proof of the Invariance under the Lorentz Transformation of the Equation of Motion of the Electron.* **L. Page.** (Phys. Rev. 24. pp. 627–630, Dec., 1924.)—The equation of motion of a spherical electron of radius a having a charge e, relative to an inertial system S′ in which it is momentarily at rest has been shown to be [see Abstract 823 (1918)] $eE' = mf' - nf'' \ldots + a_nf'^{(n)}$, where E′ is the electric intensity, f' the acceleration, m is the rest mass $e^2/6\pi ac^2$, n is $e^2/6\pi c^3$, and in general the coefficient a_n is a constant involving the charge and radius of the electron, and the velocity of light c. It is now shown that the equation of motion of the electron relative to a system with respect to which the electron has a velocity V is invariant under the Lorentz transformation. The method of proof consists in forming an equation, all the terms of which are four-dimensional vectors, and which reduces to the above equation when referred to the system S′. J. S. G. T.

794. *Considerations with Respect to Time and its Measurement.* **K. Vogtherr.** (Phys. Zeits. 25. pp. 609–617, Dec. 1, 1924.)—The great philosophic service claimed to be rendered by the relativity theory is the new conception given to the idea of time and especially to the simultaneity of separate events. This claim is examined at great length in the present paper, which should be consulted in its entirety. H. H. Ho.

795. *The Principle of Equivalence on the Theory of Relativity.* **T. Y. Thomas.** (Phil. Mag. 48. pp. 1056–1068, Dec., 1924.)—The restatement of the principle of equivalence by Einstein [Abstract 853 (1916)] assumes, in order to extend the principle to non-homogeneous gravitational fields, that the special theory of relativity is valid within an infinitely small four-dimensional region provided the coordinate system is properly chosen. The author shows that *point-inertial* systems of coordinates, defined by the metric $dl^2 = dy_0^2 - dy_1^2 - dy_2^2 - dy_3^2$, and which are closely related to the ordinary inertial system of the special theory, appear to be the proper choice of coordinates referred to by Einstein. Some of the laws (invariant equations) of the general

theory will then have the exact form of the corresponding laws of the special theory when referred to the origin of the point-inertial system. The principle of equivalence in this form is applied to equations relating to the propagation of potential, the gravitational field, the motion of a particle, and the track of a light ray [see Abstract 1468 (1911)].
J. S. G. T.

796. *A Formula of the Theory of Relativity.* **C. Henry.** (Comptes Rendus, 179. pp. 1310–1313, Dec. 8, 1924.)—According to the theory of relativity, a loss of mass, $-\Delta\mu = QJ/V^2$, occurs when heat Q is evolved in a process of chemical combination (J denotes the mechanical equivalent of heat and V the velocity of light). Assuming that the gravitational constant is, to a slight degree, dependent upon the nature of the attracting masses, the value of $\Delta\mu$ is correlated with the variations of instantaneous temperatures previously defined [see Abstract 2611 (1924)], the result permitting the retention of Lavoisier's postulate of the conservation of mass in a chemical reaction. J. S. G. T.

797. *Huyghens' [Theory of] Optics and the Theory of Relativity.* **W. Rivier.** (Arch. des Sciences, 6. pp. 350–380, Nov.–Dec., 1924.)—The author examines the concept of simultaneity of events, and postulates a "common sense" definition of simultaneity which is in accord with the principle of equivalence of Galilean systems of reference as regards the propagation of light waves. The inadequacy of the classical theory of wave propagation in the light of contemporary developments is briefly referred to, and the author attempts to reconcile the principle of equivalence with the Newtonian concept of time. A luminous source is conceived as emitting a large number of groups of wave trains having the same real period but differing as regards their real velocities of propagation. A luminous phenomenon is observed by an observer at P at a definite instant only when at that instant and point there are propagated wave trains of the nature referred to which have an apparent velocity equal to the Maxwellian constant. The theory based on these hypotheses is developed to explain various optical phenomena, *e.g.* the negative result of the Michelson-Morley experiment, etc., and to generalise Huyghens' conception of the propagation of the wave front. J. S. G. T.

798. *The Problem of Measuring Gravity at Sea.* **W. G. Duffield.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 161–204, Dec., 1924.)—The following methods were employed to obtain measurements of gravity during a voyage from Great Britain to Australia and back in 1922–23: (1) The photographic registering barometer designed by Hecker; (2) a gravity barometer; (3) a gravity spring balance. In order to obtain continuous records from the gravity barometer and gravity spring balance a special timing device and injector mechanism, which provided automatic adjustment not affected by any regular up and down motion of the ship, were constructed. The apparatus was installed in the refrigerating chambers of the vessels. In consequence of various instrumental defects which became apparent during the outward voyage the apparatus was largely reconstructed in Australia. During the greater part of the return voyage readings were obtained from the Hecker apparatus and the gravity spring balance; the latter instrument had been redesigned, the accuracy aimed at being 0·005 cm./sec.², No satisfactory results were obtained from the gravity barometer owing to air leaking into the instrument. The results have been corrected for variations of temperature and the records standardised from assumed values of *g* at Liverpool and Durban. The evidence obtained is in favour of the value of gravity being high near Continental land masses and small in deep water; it is concluded that the observed gravity anomaly cannot be due to the error caused by the rolling of the ship as at present understood. A. W. L.

METEOROLOGY AND GEO-PHYSICS.

799. *The Notion of Interference in Dynamical Meteorology.* **P. Wehrlé and A. Viaut.** (Comptes Rendus, 179. pp. 1276–1278, Dec. 1, 1924.) A. W. L.

800. *Frequency of Meteorites.* **C. Lönnqvist.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. 25. [39 pp.] 1924.)—A full summary of earlier work by Newton [Abstract 663 (1910)], Farrington, Niessl, Schiaparelli, Lehmann-Filhé, and Hoffmeister is given. It is found that meteoric paths cutting the earth's atmosphere are predominantly parallel, or nearly parallel, to the ecliptic, partly because of the earth's attraction. Also these paths are less frequent for meteorites with greater geocentric velocities. The result is confirmed by statistics on the frequency of meteorites at different hours of the day. An expression is obtained connecting the probability of penetration into the atmosphere with the initial velocity of the meteorites. The frequency of meteorites throughout the year depends on the approach of two stellar streams near to the solar system, the maximum in May–June being well marked, but another later in the year is less sharp. R. S. R.

801. *Van Bemmelen on the Intertropical Part of the General Circulation of the Atmosphere.* **B. M. Varney.** (Monthly Weather Rev. 52. pp. 441–446, Sept., 1924.)—This paper contains a further discussion of the results obtained from pilot balloon flights at Batavia during the period 1909–1917, combined with evidence concerning the intertropical circulation deduced from the observed motion of cirrus in that region. The predominant winds have been determined for each month at levels up to 24 km. and show considerable seasonal changes; the sequence of winds on ascent from the surface is as follows: (1) The monsoons; west from November to April and east throughout the remainder of the year. (2) The trade wind between east and south-east throughout the year. (3) A deep "pseudo-antitrade," largely between east and north-east throughout the year. (4) The upper trade wind from directions south of east at certain altitudes and times of year. (5) An east wind persisting through nine months of the year designated as the Krakatoa wind. (6) A high altitude west wind also occurs above the antitrade during part of the year, with components of motion from the south. The deviations of the trade and upper trade winds from the isobars are considerable and are ascribed to the frictional effects of convection currents. It is difficult to explain the high-altitude west wind, but it may be connected with the general west to east circulation of the southern hemisphere. The discussion of the relation of the air streams to the intertropical circulation is mainly centred upon the significance of the equatorward component in the motion of the upper trade and the high-altitude west wind and of the poleward component in the antitrade. The circulations found by van Bemmelen are in good agreement with those which would result from a distribution of pressure similar to that computed by Shaw for the Northern Hemisphere at 8 km.; thus the evidence suggests that the belt of high pressure south of the equator is broken up into distinct centres, which are displaced towards the equator in the upper layers. The resulting anticyclonic circulations would be fed in the lower levels from the trade wind and would serve: (1) To deliver air as the antitrade into higher latitudes; (2) to furnish the driving force for the great east to west current in the highest levels studied. A. W. L.

802. *Variation of Wind Speed with Height for Low Altitudes.* **E. Huguenard, A. Magnan** and **A. Planiol.** (Comptes Rendus, 179. pp. 1067–1070, Nov. 17, 1924.)—Two electrical anemometers are employed, one maintained at a height of 2 metres from the ground and the other at heights ranging from 0·5 to 30·5 metres. Observations were made for winds parallel and perpendicular to the shore at Couarde (Ile de Ré) and for winds on the high ground at St. Inglevert. The results are set out by curves. With certain squalls vortices are detected with a horizontal axis perpendicular to the wind direction and with a diameter of the order of 10–15 metres. R. S. R.

803. *A Systematically Varying Period with an Average Length of 28 Months in Weather and Solar Phenomena.* **H. W. Clough.** (Monthly Weather Rev. 52. pp. 421–439; Disc., by **C. F. Marvin,** 439–441, Sept., 1924.)—Statistical methods have been employed to determine the extent to which a given succession of meteorological data differs from a fortuitous sequence, and evidence is found in favour of a regular cycle with a period between 2 and 2½ years. A modified form of Wolfer's method of determining solar epochs is employed to find the epochs of maximum and minimum shown in records of temperature, pressure, variations of pressure, rainfall, lake levels, and velocity of moving low-pressure systems. The records of temperature and pressure for Europe and the United States are studied in detail in order to estimate the difference in phase between these regions; no measurable deviation is found between the phases of pressure over south-western Europe and of temperature over northern Europe and the northern United States. The mean length of the period is about 28 months, subject to systematic variations attributed to the 11-year sunspot cycle, the 35-year Brückner variation, and to a long secular change; similar periodicity is indicated in the variations of the mean latitude of sunspots and in Wolfer's smoothed sunspot numbers, these periods also being affected by the longer cycles. A graphical method of tabulation is described which combines the ordinary periodicity tabulation with any phase difference which may occur between the existing period and the time covered by the rows in the tabulation. A. W. L.

804. *Application of Schuster's Periodogram to Long Rainfall Records, beginning* 1748. **D. Alter.** (Monthly Weather Rev. 52. pp. 479–487, Oct., 1924.)—In continuation of earlier investigations into the periodicity of rainfall [Abstract 1328 (1923)], data for various parts of the world have been analysed by the periodogram method with a view to investigating any periodicities greater than 8 years. It is probable that one or more periods exist in the neighbourhood of 10 years and in the region between 13 and 16 years; no evidence is found in favour of an 11-year period. A. W. L.

805. *Hygrometry in Deep Mines.* **R. S. Jones.** (Colliery Guardian, 128. pp. 1437–1438, Dec. 5, and pp. 1499–1500, Dec. 12, 1924. Paper read before the Inst. of Mining and Metallurgy, London, Oct., 1924.)—A number of tables is given dealing with the meteorology, and especially the hygrometry, of the ventilating air in hot and deep metal mines. These have been expanded from earlier meteorological tables to cover the bigger range of pressures encountered in mines. For practical purposes grains of water-vapour per lb. of dry air were tabulated, and the only additional observations needed would be the dry and wet bulb temperatures in order to obtain all the information required. The method by which each table has been calculated, and also the fundamental constants on which the tables depend, are given. The tables are then applied to the conditions existing in deep mines, and the advantages and disadvantages of an air-conditioning plant placed outside or at the bottom of the mine are considered. For actual observation the author employed a type of whirling hygrometer which gave satisfactory results, and curves and observations are included. In conclusion it is suggested that the five quantities—dry and wet bulb temperatures, grains of water per lb. of dry air, heat increase and air velocity—are all that are required to determine completely any problem connected with the ventilation of deep mines. In the subsequent *Discussion* the disadvantages of underground cooling plant, and the usefulness of a hair hygrometer when frequently calibrated and carefully handled, were emphasised. R. S. R.

806. *The Integration of the Equation of the Dynamical Theory of the Tides.* **M. Gevrey.** (Comptes Rendus, 179. pp. 1243–1246, Dec. 1, 1924.)—The determination of the oscillations, of given period, of a gravitating ocean, gives rise to an integro-differential equation. For a finite oceanic basin, with vertical shores, it is shown that this may be reduced to a single integral equation, and that the solution is unique. That the same results can be obtained for a basin with an opening in the boundary, giving connection with a large ocean, is indicated. W. G. B.

807. *Temperature Lag of the Oceans.* **W. J. Humphreys.** (Monthly Weather Rev. 52. pp. 490–491, Oct., 1924.)—Approximate calculations have been made of the temperature lag of the oceans, assuming that any temperature changes extend to a depth of 20 metres and neglecting land effects. If the oceans become 1° C. warmer the excess temperature falls to 0·5° C., 0·25° C., and 0·1° C. in approximately 179, 358, and 596 days respectively. A. W. L.

808. *Radial Distribution of Elements in the Earth.* **H. S. Washington.** (Washington Acad. Sci., J. 14. pp. 435–442, Nov. 19, 1924.)—Taking the view that the earth possesses a core of nickel-iron passing into a peridotic shell, and hence into the outer silicate crust as established, the distribution of the chemical elements is discussed in the light of recent evidence. The core contains neither oxides nor silicates, but non-oxidic compounds, such as phosphides, carbides, etc. There is a progressive increase of silicon and oxygen outwards, and a decrease of iron. Superimposed on these two inverse progressions are progressions in the basic elements of the silicates. Iron and magnesium at first increase outwards from the core, reach a maximum, and then steadily decline until in the outer granitic crust they are almost negligible. Calcium and sodium appear in the peridotic shell and calcium reaches a maximum at the base of the outer crust. Thereafter the alkali metals increase and calcium decreases. Aluminium for special reasons is concentrated mainly outwards. These progressions follow the order of affinity for silica; the order of the oxidisability of the metals concerned. In other words the elements appear from the surface downwards according to their position in the electrochemical series, namely, K, Na, Ca, Mg, (Al), Fe, Ni. W. A. R.

809. *Figure of the Earth and Mean Motions of the Moon's Perigee and Node.* **H. S. Jones.** (Roy. Astron. Soc., M.N. 85. pp. 36–37, Nov., 1924.)—From the discrepancy between Brown's figures for the longitude of perigee and node and Hansen's, corrected by the Cape observations of occultations from 1880–1922, the ellipticity of the earth is calculated. Brown's figures are substantially correct for epoch 1850 and the corrected Hansen values for 1900. From the motion of the perigee is obtained the value 1/294·8 and from the motion of the node 1/294·9. Corrections are applied to Brown's expressions for the mean longitudes, epoch 1900. A. Wh.

810. *Earth Temperatures at Moderate Depths.* **L. H. Adams.** (Washington Acad. Sci., J. 14. pp. 459–472, Dec. 4, 1924.)—To calculate the temperatures within the earth it is necessary to determine the initial temperature-distribution at the time the earth began to cool as a solid body. Due allowance must be made in subsequent calculations for the effect of radio-active disintegration. A curve of temperature-distribution to a depth of 300 km. is given. This is based on an initial temperature distribution depending on the crystallisation of a peridotic rock melt. The initial distribution has no effect on depths down to 100 km., but those below this depend almost entirely on the original distribution. W. A. R.

811. *The So-called "Annual" Periodicity in the Occurrence of Earthquakes.* **H. H. Turner.** (Roy. Astron. Soc., M. N. Geophys. Suppt. 1. pp. 204–217, Dec., 1924.)—An investigation of earthquake records for the northern hemisphere during the period 1913–1920 shows that the frequency of occurrence was greater in summer than in winter. This is not in agreement with the results obtained for other periods, consequently the Tokyo records from 1876 to 1889 and Chinese records covering the period 700–1600, have been studied in detail to investigate any regular change in the date of maximum. It is concluded that the predominant variation has a period slightly less than a year, the maximum travelling backwards about one month in 80 years; there is also a fluctuation with a period of about 80 years and range about 3½ months. A systematic difference occurs between the two series showing that the maximum occurs 5 months later in Japan than in China; if corrected for the 80-year fluctuation this difference is reduced to 3 months. A. W. L.

LIGHT.

812. *Effects of Varying the Wave-Length of the Stimulating Light upon the Electrical Response of the Retina.* **E. L. Chaffee and A. Hampson.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 1–25, July, 1924.)—The posterior half of a frog's eye is placed in a moist chamber and connections made to a point on the retina and to the optic nerve through threads moistened with Ringer's solution; the other ends of the threads are connected through non-polarisable electrodes to a thermionic valve amplifier; this is connected to a string galvanometer the movements of which are photographed; thus the variations of the potential of the retina are magnified and recorded. In a previous investigation white light was employed, and the complex time curves obtained were analysed into four definite and typical components, the first, second, third, and fourth maxima; the first and second maxima can be reasonably attributed to the cones and rods respectively. The authors now use the method for light of different colours. A curve is given showing the response for constant energy at different wave-lengths; this runs nearly horizontally from $0 \cdot 400\,\mu$ to a little beyond $0 \cdot 500\,\mu$, rises slightly to a maximum value, but begins to drop almost at once, falling off very rapidly beyond $0 \cdot 600\,\mu$; another diagram gives similar curves for five smaller values of the energy; these show that when the amount of energy is small the proportional response in the extreme violet is much smaller than at about $0 \cdot 520\,\mu$, but at the same time the point of maximum response is shifted in the direction of the violet; this shift cannot be interpreted as due to what in the human eye is known as the Purkinje effect, since the method of obtaining the results is different in the two cases. Curves are also obtained for the same colour, with different amounts of light energy in the stimulating flashes, the responses R being plotted against intensity or energy I. To analyse the result log R is plotted against log I, this shows a straight portion at low intensities; when R is plotted against log I the graph is straight for medium intensities; there is a third region of relatively high intensities for which no law has been deduced. Similar results are obtained with red, orange, green, blue, and violet light, the log R—log I plots for all colours being parallel straight lines for low intensities, the law breaking down at about the same response for all colours; the straight-line portions of the R—log I graphs are also parallel up to about the same response for all colours. A simple mathematical treatment leads to the conclusion that there is no quantitative difference in the laws of variation of maximum response for different colours. It is also proved that there is no qualitative difference in the shape of the response-time curves for different colours, and no selective fatigue when the retina is exposed to light of one colour. The visibility curve obtained is similar in shape to that for colour vision of the human eye, but shifted towards the violet; it nearly coincides with the low-intensity visibility curve of human vision. H. N. A.

813. *Quantitative Investigations on Vanadium Pentoxide Sol. I. Flow Anisotropy. II. The Eddy Cross.* **H. Freundlich, F. Stapelfeldt and H. Zocher.** (Zeits. phys. Chem. 114. pp. 161–189 and 190–207, Dec. 24, 1924.)—The double refraction and dichroism—termed together anisotropy—observed in flowing sols of vanadium pentoxide gradually increase from zero in a freshly prepared sol to a maximum value. This ageing, followed by the increases in the double refraction, Δ, and dichroism, Γ, proceeds as a reaction of the second order, provided that the velocity of flow and temperature remain constant:

$$\frac{d\Delta}{dt} = k_\Delta(\Delta_\infty - \Delta)^2 \quad \text{and} \quad \frac{d\Gamma}{dt} = k_\Gamma(\Gamma_\infty - \Gamma)^2$$

Impurities, in particular arsenic acid, even in low concentration, greatly depress the velocity of ageing. The influence of temperature on the ageing is expressed by equations of the form $lnk_\Delta = - A_\Delta/T + B_\Delta$, the constants A_Δ and A_Γ having values of over 10,000, and the temperature coefficient for 10° being about 4. Continued dilution of a sol which has reached the limiting value results first in diminution of the flow anisotropy in proportion to the dilution and later in a slower diminution to a new limiting value. Flow anisotropy increases with the velocity of flow. With fresh sols this increase is linear up to the highest velocities attainable without turbulence, but with older sols a state of saturation is reached at some earlier stage. Rise of temperature is accompanied by decrease of the flow anisotropy according to a practically linear law: $\Delta = - m_\Delta t + n_\Delta$ and $\Gamma = - m_\Gamma t \times n_\Gamma$, the two values of m and those of n being constant. The influence of temperature is more marked with the fresh than with the old sols. Within the limits of experimental error, the double refraction of the V_2O_5 in a sol, calculated from the limiting value, coincides with that of a thin layer of V_2O_5 itself. The absolute value of this double refraction is high, amounting to 1·7. The so-called eddy cross, seen when the sol is rotated between two cylindrical walls and viewed between crossed nicols, has been investigated. Four minima of brightness are observed, making a dark cross, the arms of this forming with the directions of polarisation an angle termed the cross angle, ψ, which is virtually independent of the thickness of the layer of liquid and of the concentration of the sol, but increases considerably with the velocity and with the age of the sol, and diminishes somewhat as the temperature rises. The increase of ψ during ageing is expressed by an equation of the second order, and its temperature coefficient for 10° is about 2·3. T. H. P.

814. *New Methods for Determining the Index of Refraction of a Liquid.* **A. Sellerio.** (N. Cimento, 1. pp. 311–334, Oct.–Nov.–Dec., 1924.)—The author employed a liquid prism, the construction and use of which are illustrated by several figures. As these and the mathematical calculations cannot be reproduced in a short abstract, the original paper should be consulted. E. F.

815. *Some Problems of Colour Theory.* **J. v. Kries.** (Zeits. techn. Physik, 5. 8. pp. 327–349, 1924.)—A general view of the theory of colour sensation, including twilight vision, the Purkinje phenomenon and the mixture of colours with Ostwald's method of representation by means of a spatial model; but more especially with the question of the relative brightness of differently coloured lights and surfaces. The author seems inclined to doubt the existence of a separate brightness sensational mechanism, and thinks it possible that, when one compares the brightness of red and blue lights, the process is much the same as when one compares the strength of the taste sensation of two solutions, one of salt and one of sugar, the two concepts concerned being more or less indeterminate. In spite of this it is possible, in a number of ways, to devise definitions for equality of brightness of different coloured lights, though it does not follow that the results of measurements by the different methods on which these definitions are founded will agree with one another; results obtained with some of the methods, using bright lights, do not agree with measurements made when the brightness of both lights are diminished in the same proportion, so that the yellow spot of the retina with its cones is no longer active, and only the rods in the peripheral portions of the retina are concerned, giving twilight vision. For the illuminating engineer the important factor in comparing brightness is generally the amount of resolution of detail possible with the lights to be compared, and two lights may be regarded as equally bright when they give the same resolving power; it is not easy to use this principle for direct measurements and the author is inclined to think that the minimum field method, in which the parts of the retina in and near the yellow spot are chiefly employed, should give equality of brightness when the resolving powers are equal. A method is described which can be employed in testing lamps in which the variation from pure white is small; the two lamps illuminate two small adjacent fields, which can be adjusted so as to be a little brighter or a little darker than the surrounding field, so as to stand out equally strongly from it. Even in daylight, however, the effect of peripheral vision may not be always negligible, and a night-blind person may not get the same impression of brightness from different colours in daylight as one who has "cat's eyes" and can see well in the dark. The question of relative brightness in the art of painting and in photography is also considered. H. N. A.

816. *On the Colour of the Sea.* **W. Shoulejkin.** (Ann. d. Physik, 75. 8. pp. 825–826, Dec., 1924.)—The author complains that Gans [Abstract 2710 (1924)] has not read his papers on this subject, since they have priority over Raman. He now repeats briefly his main conclusions [see Abstract 2241 (1924)] which are not in accord with the Gans theory, and a short criticism of the latter is included. H. H. Ho.

817. *The Effective Wave-Length of Coloured Glass Used in Optical Pyrometry.* **F. Henning.** (Zeits. f. Physik, 30. 4–5. pp. 285–296, 1924. From the Reichsanstalt.)—By deduction from theoretical considerations the effective wave-length of a coloured glass is shown to be a function of the colour temperature of the radiation transmitted through the glass. An expression is established for the effective wave-length and is obtained from a comparison of the brightness of two sources of radiation of different colour temperatures. The results so obtained are compared with the values calculated by Forsyth and Hofmann for the effective wave-length of Schott red glass F.4512, and good agreement is established. The results are compared in tabular form. S. G. B.

818. *Spectral Distribution of Mixtures Produced by Maxwell Disc.* **D. B. Judd.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 95–111, Aug., 1924.)—The author has determined the spectral reflection curves for a number of specimens of paper used on Maxwell's disc in the study of the phenomena of colour mixture. The spectral distributions of the mixtures which gave a sensation match with grey were thus determined and it was found that in certain combinations, *viz.* those in which there was a yellow component in the mixed lights, the spectral distribution was practically the same as that of the grey, *i.e.* the match was the result of physical identity of composition. In the case of mixtures from which yellow was absent, however, the spectral composition was far removed from that of the grey with which it gave a sensation match, *i.e.* the match was the result of psycho-physiological action in the eye as in the case of a mixture of spectrum lights. J. W. T. W.

819. *Simulating Natural Light in Metallography.* **H. S. George.** (Am. Inst. Mining Eng., Trans. 70. pp. 259–273, 1924.)—A method of illumination that enhances the value of the microscopic study of opaque materials, as in metallography, consists in the partial eclipse of the illuminating beam by the insertion in its path of opaque discs of various diameters so as to stop off to various extents the axial rays. Structures possessing a relief are given a natural appearance and erroneous interpretation is avoided. The system is referred to as "conical illumination." Illustrations are given of microphotographs of sections of an iron-chromium-carbon alloy showing the obliteration by axial illumination of a constituent shown plainly by conical illumination. In another example, etching figures in ferrite, hitherto considered to be pits, are revealed as pyramids, standing in bas-relief. A. B. C. L.

820. *Apparatus for Broadening Spectra.* **W. J. S. Lockyer.** (Roy. Astron. Soc., M.N. 85. pp. 47–55, Nov., 1924.)—The author points out the difficulties commonly experienced in obtaining broad spectra in the case of the slit spectroscope, prismatic camera, and by direct enlargement methods. In the latter case the enlargement of the grains of the plate give rise to a mottled effect. A new form of instrument, based on the "clepsydra" principle, is next described in detail, showing how the negative is made to fall vertically by gravity and its speed controlled by the flow of oil in a cylinder. He gives an account also of the preparation and adjustment of the original negative to produce the enlarged broadened positive. The results of an examination, relative to the speed of fall of the negative to determine the durations of the exposures, are next given, and curves are included which illustrate those speeds for different valve readings and for different temperatures. Finally, a description is given showing how this enlarged and broadened positive is converted into a negative of any desired scale; this is followed by an account of the method of preparing the paper print for reproduction purposes. A. W. J.

821. *Measurement of Lens-Aberrations.* **K. Butkow.** (Zeits. f. Physik, 30. 4–5. pp. 268–276, 1924.)—Experimental tests of the method devised by the author [Abstract 1760 (1924)] for measurement with the aid of a Twyman interferometer. Quantitative results were obtained in agreement with those given by the Hartmann method. A. D.

822. *The Effect of Diffraction and Chromatic Aberration in the Absence of other Aberrations.* **A. Buxton.** (Roy. Astron. Soc., M.N. 85. pp. 78–82, Nov., 1924.)—The intensities in a point source image subject to the diffraction and chromatic aberration are obtained and the results extended to the cases of the luminous line and plane sources. A. Wh.

823. *White Light Interference Fringes with a Thick Glass Plate.* **W. N. Birchby.** (Nat. Acad. Sci., Proc. 10. pp. 452–457, Nov., 1924.)—In the Michelson interferometer the mirrors are adjusted in sodium light for circular fringes and the paths made equal. After insertion of the glass plate in one of the paths, the latter are adjusted to produce the sharpest sodium maximum. The substitution of white light produces fringe effects of the character of those described by Sethi [see Abstract 1436 (1924)]. Diagrammatic representations of the theory are given and an expression is developed for the number of fringes visible with plates of different thickness and dispersive power. A. B. C. L.

824. *Interference and the Dynamics of Light Quanta.* **L. de Broglie.** (Comptes Rendus, 179. pp. 1039–1041, Nov. 17, 1924.)—Reference is made to previous studies of quantum dynamics and the wave theory of light and to an assumption therein made, of an essential relationship between the state of interference of the waves and the probability of absorption of luminous atoms by matter, which is now considered untenable. The rays required by the undulatory theories are now regarded as possible trajectories of the quanta, the bright and obscure fringes observed with interference corresponding respectively with concentrations and rarefactions of rays. A. B. C. L.

825. *Molecular Dispersion of Light in Liquids.* **R. Gans.** (Zeits. f. Physik, 30. 4–5. pp. 231–239, 1924.)—The depolarisation of the molecular light dispersion was measured for twenty pure liquids, and the results show a good agreement with the Kerr constant. The relative intensities of the Tyndall radiation of different substances agree, so far as order of magnitude, with the experimental results obtained. [See Abstract 2405 (1923).] F. J. B.

826. *Optical Projection of the Tracks of α-Particles.* **H. T. Pye.** (Frank. Inst., J. 198. pp. 813–816, Dec., 1924.)—The well-known expansion apparatus due to C. T. R. Wilson, does not lend itself readily to projection so that a large audience may see the tracks of α-particles. The same is true of the Shimizu modification of Wilson's apparatus. Reflectoscope methods have so far not proved practicable. The writer has devised a modification of the Wilson-Shimizu apparatus so that light from an arc lamp passes through the expansion chamber, and the shadows of the tracks are clearly shown on a screen by the usual projection methods. A. S. Eve states in an added note that this apparatus when well developed is likely to have a large and important vogue for popular audiences and for instructional purposes; possibly it may have its uses for research work also. A. E. G.

827. *Systematic Error in Michelson's Grating.* **Rita Brunetti.** (N. Cimento, 1. pp. 263–276, Oct.–Nov.–Dec., 1924.)—The slight displacement between the maximum of interference and the minimum of diffraction results in differences of $\delta\lambda$ which for radiations at small distances from the origin are not negligible in comparison with errors of observation. [See Abstract 830 (1924).] A. D.

828. *Study of Optically-Active Compounds, Compounds of Malic Acid, Copper, and Bases.* **E. Darmois.** (J. de Physique et le Radium, 5. pp. 225–237, Aug., 1924.)—Malic acid forms an *acid* copper salt, $Cu(HC_4H_4O_5)_2$, which does not exhibit the Cotton effect, since the copper is present as an ion. It also forms a *basic* copper salt, which can be represented as $2H_2(C_4H_4O_5)$, 3CuO, $4H_2O$, which exhibits the Cotton phenomenon, since copper is present in a "complex ion" containing the optically-active malic radical. In this series of compounds the acid behaves as if it were tribasic, and will form salts containing an atom of sodium in addition to an atom of cupric copper. These salts have been studied by Wark, who has assigned definite constitutions to them. (Chem. Soc. J., 125. p. 2004, Oct., 1924.) T. M. L.

829. *The Optical Constants of Matter.* **C. G. Darwin.** (Cambridge Phil. Soc., Trans. 23. pp. 137–167, Nov., 1924.)—The object is to deduce the refraction, etc., of matter in bulk out of the more primitive phenomenon of the scattering of light, without having recourse to hypotheses about atoms. It is assumed that a particle exposed to monochromatic light emits a wavelet of the same frequency and proportionate amplitude, but there are no restrictions on emission in different directions. For an isotropic medium, the compounding of the scattered wave-lengths gives an integral equation, the solution of which leads to the ordinary expressions for the refracted and reflected waves, but this does not give much insight into the physical details of the process. Special cases are also studied which account for all the effects of absorption, double refraction, magnetic and natural gyration; other cases suggest the possibility of new optical effects, which are perhaps too small to be observed. T. M. L.

830. *The Nature of Undissociated Acids.* **H. v. Halban.** (Zeits. Elektrochem. 30. pp. 601–604, Dec., 1924.)—Controversy between the author and Hantzsch [see Abstracts 685 and 2859 (1924)] concerning the natures of acids and pseudo-acids and the optical properties of electrolytes. Every chemical reaction is accompanied by some change in the light absorption by the system, but an essential change in the absorption spectrum is not necessarily a sign of some change in the chemical constitution. Whether or not electrolytic dissociation influences the light absorption cannot be established by direct measurement of the absorption. H. B.

831. *Photochemical Formation of Hydrogen Bromide and Velocity of Formation of the Bromine Molecule from the Atoms.* **M. Bodenstein** and **H. Lütkemeyer.** (Zeits. phys. Chem. 114. pp. 208–236, Dec. 24, 1924.)—Under the influence of moderately intense radiation, combination of hydrogen and bromine takes place with a velocity about 300 times as great as that of the same reaction in the dark at the same temperatures (160°–218°) and according to a law which follows readily from that of the reaction in the dark. In the latter case the velocity is conditioned by that with which hydrogen reacts with the bromine atoms in equilibrium with its molecules, the concentration of the bromine atoms depending on the velocity of decomposition of Br_2 and the velocity of recombination of 2 Br. When the reaction occurs in the light the velocity of the spontaneous decomposition of Br_2 must be replaced by that of the decomposition of Br_2 by the light quanta absorbed. Thus the reaction in the light is expressed by the equation;

$$+\frac{d[HBr]}{dt}=\frac{k\,.\,\sqrt{J \text{ absorbed}}\,.\,[H_2]}{1+\frac{[HBr]}{10[Br_2]}}$$

Measurement of the light quanta absorbed allows of a determination of the velocity with which the bromine atoms form and recombine, and comparison of the velocities in the light and in the dark, combined with the known dissociation equilibrium of bromine vapour, gives the concentration of the bromine atoms. Further, the number of impacts of the bromine atoms may then be calculated, and comparison of this number with that of the combinations occurring between the atoms to form molecules shows that only 0·125 per cent. of the total number of impacts leads to combination, this result being independent of the total pressure of the gases and—within the limits of temperature employed—of the temperature. This result disagrees with certain theoretical expectations, and further measurements at considerably diminished pressures are to be made. T. H. P.

832. *History and Theory of the Latent [Photographic] Image.* **Lüppo-Cramer.** (Zeits. wiss. Phot. 23. pp. 91–98, Dec., 1924.)—Historical and polemical. T. H. P.

833. *The Blackening of a Photographic Film by X-Rays.* **J. K. Robertson** and **J. T. Thwaites.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 99–101, 1924.)—In the region of ordinary light it is well known that there may be considerable deviation from Bunsen's reciprocity law, *i.e.* that when the intensity (I) of a source and the time of exposure (T) are varied in such a way that their product is constant, equal degrees of blackening are not produced on a photographic plate. Equal degrees of blackening are obtained, however, when IT^p is kept constant where p is in the region of 0·86. In the field of X-rays $p = 1$ nearly. The present paper describes a wedge method for the determination of p, a beam of X-rays falling on a wedge of iron placed directly over a narrow slit between two sheets of thick lead. Values of p obtained were 1·05, 0·97, 1·04, 0·91, and 0·92. W. V. M.

834. *Photographic Blackening.* **E. Stenger** and **G. v. Kujawa.** (Zeits. wiss. Phot. 23. pp. 80–84, Dec., 1924.)—Descriptions of the Martens photometer and the Goldberg densograph are given. The results from these are compared; they concur at the middle of the curves, and there is no systematic error. The Martens photometer is preferred. A new calculating scale is also described. A. D.

835. *The Photographic Blackening Curve.* **W. Meidinger.** (Zeits. phys. Chem. 114. pp. 89–113, Dec. 13, 1924.)—The dependence of the velocity of developing on the concentration of the components of the developer is investigated. The validity of the mass action laws are in this way proved. The lag action of potassium bromide in the developer is carefully examined and it is established that the lag converges toward a limiting value. Explanation of this limiting value is given on the assumption of adsorption at the grain surface. The action of chlorine

and iodine ions in the developer is investigated. The influence of the time of developing on the blackening curve is determined and it is shown that with correct correction for fog the blackening fog converges towards an end form. An exact fog correction is given. It is established that with longer lighting and shorter developing or shorter lighting and longer developing, for the same blackening with the same type of emulsion, the same quantity of silver will be separated. Physical developing under different conditions is compared with the chemical. The blackening curve with physical developing is determined and discussed. The connection between the size of the grain and sensitivity is considered. The relative sensitivity of photographic plates to light and α-rays is determined. It is shown that the action of α-rays may be considered, in the first approximation, as proportional to the mass of silver bromide in the layer. The blackening curve for two types of emulsion is ascertained by counting the grains and titration. [See also Abstract 490 (1924).]
A. E. G.

836. *Emulsion Ripening.* **Lüppo-Cramer.** (Zeits. wiss. Phot. 23. pp. 84–90, and pp. 111–119, Dec., 1924.)—It is generally admitted that sensitiveness increases with increasing size of the AgBr granule. The author finds that latent fogging manifests itself more readily under the same conditions. It is improbable that a big granule is more readily reduced by the gelatine; it is more probable that an inhibiting effect of the gelatine is less felt by the big granule. This would provisionally explain both phenomena.
A. D.

837. *The Effect of Heat Treatment upon the Kathodo-Phosphorescence of Fluorite.* **F. G. Wick** and **J. M. Gleason.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 639–648, Dec., 1924.)—Abstract 105 (1925) records the previous work on this subject by the same authors. The investigations now recorded show the changes, wrought by heating fluorite specimens before excitation, upon the phosphorescence excited by kathode rays and include a study of the effect of previous excitation and variation of the bombardment period. The experimental method was as before, using a Lummer-Brodhun cube. Curves and detailed results are given showing the difference in behaviour between the natural and fused specimens. The paper concludes with the suggestion that the differences in behaviour may be due to a fundamental difference in the nature of the radiators producing phosphorescence. For fused samples the phosphorescence is practically confined to the red end of the spectrum and exhibits conspicuous line-like bands. Natural specimens show a luminescence originating from broad diffuse bands. The former line-like bands may be due to atomic radiators, and the latter broad bands to molecular vibrators.
S. G. B.

838. *Polarisation of Resonance Radiation in Magnetic Fields.* **A. Ellett.** (Nature, 114. pp. 931–932, Dec. 27, 1924.)—In D-line resonance radiation with the magnetic field, the azimuth of the maximum polarisation is no longer parallel to OY [see Abstract 1861 (1923)] but is rotated in the direction of the Larmor precession. The angle of rotation is not directly proportional to the intensity of the field, probably because the interval between absorption and emission is not the same for all atoms. With D_2 resonance radiation of sodium, a field of 3·6 gauss rotates the azimuth of maximum polarisation 16·5°, and a field of 13·5 gauss rotates it 21°. The sodium used in making these observations was freed from hydrogen as completely as possible and at temperatures of 85° to 95°, where the vapour pressure of the sodium is so low that the time of a free path is large compared with τ, the average interval between absorption and re-emission. By making suitable assumptions as to the manner of distribution of the time intervals between absorption and emission, the value of τ may be calculated from this rotation. T. H. P.

839. *The Influence of Magnetic Fields on the Polarisation of Resonance Radiation.* **W. Hanle.** (Zeits. f. Physik, 30. 2. pp. 93–105, 1924.)—A summary is given of the related work, published during the past two years, of Wood and Ellett, Joos, Breit, Gaviola and Pringsheim, and Ruark, Foote and Mohler [Abstracts 2052, 2068, and 2497 (1924)]. Experimental details are given of a method in which the author proved that, for the resonant radiation of Hg vapour, not only do magnetic fields depolarise the polarised radiation, but that also the plane of polarisation is rotated. The effects are produced by neutralising the earth's magnetic field and then employing field strengths up to 2 gauss. Reasons are given by which the effects obtained can be differentiated from the Faraday effect, and an explanation of the results on the quantum theory is discussed. The experiments of Wood and Ellett were supplemented in one respect in which a deviation from theory appears probable. The resonant radiation was further examined when excited by elliptically polarised light. R. S. R.

840. *Electronic States of the CN Molecule.* **R. S. Mulliken.** (Nature, 114. pp. 858–859, Dec. 13, 1924.)—Comparatively little attention has been paid as yet to the electronic changes involved in the emission of band spectra, and the present note deals with an examination of the CN bands from this standpoint. Reasons are given for the statement that the long dispute as to whether carbon in addition to nitrogen is required for the emission of these bands has been decided in the affirmative. The red and violet CN bands were shown by Heurlinger to have a common final electronic state which is now opined in all probability to be the normal state of the CN molecule. Since the low resonance potentials of CN indicate a low ionisation potential, it appears likely that CN is largely ionised at the higher stellar temperatures. H. H. Ho.

841. *Controlled Orbital Transfers of Electrons in Mercury-Vapour.* **R. W. Wood.** (Roy. Soc., Proc. 106. pp. 679–694, Dec. 1, 1924.)—Mercury-vapour is exposed to radiation of wave-length 2536 from a water-cooled mercury arc which may be screened with bromine vapour. The radiation raises electrons from the 1S orbit to the $2p$ orbit where they are able to absorb radiation from another unscreened arc and give out a series of lines corresponding to electrons terminating at this level, being raised to other levels and falling back in various ways. A complete schedule of the emission is obtained by filtering different frequencies out of the exciting light and noting the effect on the relative intensities of the excited radiations. With light filtered through bromine vapour, the electrons absorb 2536 and rise from 1S to $2p_2$. Then they absorb 3125 rising to d' and 3131 to d''. From d'' they fall to $2p_1$ emitting 3663 or to $2p_3$ emitting 2967 or to $2p_2$ emitting 3131. From $2p_2$ electrons either return to 1S or reabsorb suitable radiation. Electrons on $2p_3$ may absorb 2967 and rise to d''. Electrons on $2p_1$ cannot transfer since 3650, 3654, 3663 are absent. In another group of lines, 5461, 4358, 4046, radiation is due to absorption of 4358 and transfer from $2p_2$ to 2S. In the presence of 2 mm. of nitrogen, the intensities of these lines rise enormously, 5461 thirty times, 4358 sixteen times, and 4046 eight times. This is due to the greatly enhanced absorption of 4046, raising electrons from the metastable $2p_3$ to 2S. Thence they fall back to $2p_1$ giving 5461, $2p_2$ giving 4358, and $2p_3$ giving 4046. This fact is used tentatively as an argument against the theory that the majority of electrons return directly to the orbits whence they have been raised by excitation. Excitation of other spectra in the presence of gases is noticed and emphasis is laid on the importance of the structure of 2536, since all these phenomena depend on excitation by it. Further study of the structure of this line in emission and absorption will be made. A. Wh.

842. *Common Properties of Spectra.* **H. Deslandres.** (Comptes Rendus, 179. pp. 1006–1011, Nov. 17, 1924.)—In a previous paper [Abstract 573 (1920)] the author showed that in certain band spectra the vibration number of the head of the most intense band is, with small discrepancies, a multiple of the same infra-red frequency 1062·5. More recently it was found [Abstract 2761 (1924)] that the same law applied to an important group of line spectra. The most brilliant line of a simple substance, and its ultimate lines, expressed in vibration numbers, are very frequently multiples of 1062·5. A table is given of further series lines and very bright lines found in agreement with the above. Discussion of the results leads to the conclusion that the helium nucleus has a preponderant effect. The lines conforming to the law are more numerous in the case of atoms whose atomic weight is a multiple of 4, and whose nuclei appear to be formed by the juxtaposition of helium nuclei, and it would thus appear that the lines attributed to atomic nuclei ought to be simply the vibrations of the helium nucleus, which is found in all the other nuclei. A. W.

843. *Classification of Terms in Spectra.* **W. M. Hicks.** (Phil. Mag. 48. pp. 1036–1048, Dec., 1924.)—The first part of the paper deals with rules laid down by Sommerfeld and extended by Landé [see Abstract 1863 (1923)] for the enumeration of species of term types, and a simplified form is suggested. The second part is concerned with a discussion of evidence for and against a rule, accepted by Landé, supposed to give the ratios of separations in multiplets. Multiplets found in the spectrum of iron are discussed in a note. F. S.

844. *Determination of Wave-Lengths of Absorption Limits.* **B. Walter.** (Zeits. f. Physik, 30. 6. pp. 350–356, 1924.)—A method is developed in which the wave-length of the absorption limits is determined. The absorption spectrum under consideration is absorbed by a Röntgen tube which is emitting a line as near as possible to the limit under measurement. From a comparison of the absorption of these lines with that of the neighbouring lines it is possible to estimate the position of the limits of the absorption bands. The method is used to determine the K-absorption limits of nickel and zinc and the wave-lengths found are 1484·5 and 1280·10^{-11} cm. respectively. F. J. B.

845. *Chemi-Luminescent Spectra of Grignard Compounds.* **R. T. Dufford, Dorothy Nightingale,** and **S. Calvert.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 405–409, Oct., 1924.)—Compounds of the type RMgX, where R is an organic radical, and X a halogen, give luminescence when oxidised with molecular oxygen if the Mg is attached to an unsaturated carbon atom in R, especially if R is an aromatic radical. The luminescence has been photographed using a spectroscope with high aperture ratio. In every case the spectrum was continuous. Some banded spectra were photographed, but these were due to unstable oxidation-products of the type ROMgX. It is concluded that the mode of formation of these compounds is not the same. A. C. M.

846. *The Spectra of some Lithium-like and Sodium-like Atoms.* **D. R. Hartree.** (Cambridge Phil. Soc., Proc. 22. pp. 409–425, Sept., 1924.)—The subject of this paper is the identification of lines of the spectra of various lithium-like and sodium-like atoms in the extreme ultra-violet hot spark spectra of the respective elements and the approximate determination of the terms of these spectra. This is done by using the relations between corresponding terms (terms corresponding to orbits of the same quantum numbers) of the spectra of different atoms of the same electronic structure. Approximate formulæ, derived theoretically, are quoted and used as extrapolation formulæ in estimating terms of unknown spectra from those of known spectra. Lines are then calculated from known terms, and correlated with observed lines when possible. In no case is the number of lines of any one series large enough for series limits to be found in the usual way, but usually it is possible to estimate one term fairly closely, and the others can then be determined from the lines identified, and then form part of the known data in estimating the terms of the spectra of other atoms of the same electronic structure. Starting from the known spectrum Li I, lines of the spectra Be II, B III, C IV, and possibly of N V and O VI are identified and approximate terms found, and from the known spectra Na I to Si IV the spectra P V and VI are treated in a similar manner. A. C. M.

847. *Some Relations between the Optical Spectra of Different Atoms of the same Electron Structure. I. Lithium-like and Sodium-like Atoms.* **D. R. Hartree.** (Roy. Soc., Proc. 106. pp. 552–580, Nov. 1, 1924.)—Some approximate relations between corresponding terms of the spectra of different atoms, ionised to such an extent that they have the same electronic structure, are obtained theoretically on the assumption that the field of the atom can be represented by a central field, and are compared with observed spectra. The relations are different according as the orbit of the series electron remains entirely outside the core or penetrates into it. If the external added field has a potential varying as the inverse mth power of the distance, and if α is the term excess for an orbit which lies entirely outside the core [$\alpha = \nu/\mathrm{R} - \mathrm{C}^2/n^2$], then for corresponding orbits of this kind, of different atoms of the same electronic structure, $(\mathrm{C}^m/\alpha)^{1/(m-1)}$ should be approximately linear in the atomic number. From an investigation of the relation between different terms of a single spectrum, the value of the index m can be found. For many spectra, the value $m = 4$ is obtained, which is the value to be expected if the external added field is due solely to polarisation of the core by the series electron. The observed values of the term excess, for orbits of different lithium-like or sodium-like atoms which lie entirely outside the core, agree closely with a linear relation of the type indicated by the theory.

For orbits of lithium-like or sodium-like atoms which penetrate into the core, it is found that the reciprocal of the quantum defect should be approximately linear in the atomic number, and comparison with experiment shows this to be the case. It is also possible to obtain approximate formulæ for the variation, from one lithium-like or sodium-like atom to another, of the change of quantum defect within a single sequence of terms, and the values deduced from observed spectra agree roughly with these formulæ. [See preceding Abstract.] A. C. M.

848. *A, P, Q, and R Combination in the Many-Lined Spectrum of Hydrogen.* **O. W. Richardson** and **T. Tanaka.** (Roy. Soc., Proc. 106. pp. 663–678, Dec. 1, 1924.)—In the course of an investigation [see Abstract 922 (1925)] of electron discharges in hydrogen at a pressure of 1 mm. or under the authors observed that some of the lines in the secondary hydrogen spectra of the three different types of discharges showed selective changes in intensity as compared with the secondary spectrum lines in the capillary of a quartz Geissler tube containing hydrogen which was used as a standard of comparison. Owing to the comparatively low pressure at which the experiments were made, the strengthened lines were mainly those constituting Fulcher's bands. There are, however, a large number of weakened lines, some of them remarkably so. These are in general different for the three types of discharge, except that a considerable number of them are high-pressure lines; these lines do not appear to have any other common feature or to belong to any previously recognised group. By selecting from these weakened lines those which have similar physical properties in other respects—as, for example, lines which are enhanced in the condensed discharge—it is possible to arrange a large proportion of them in combination with other lines of this spectrum into series with constant second differences. It is now generally accepted that the spectrum is emitted by the hydrogen molecule. Whilst the detailed configuration of this molecule is unknown, it is clear that it must be one of the simplest existing structures. The determination of the structure of the secondary hydrogen spectrum is of fundamental importance from the point of view of the quantum theory. It is generally realised that this spectrum is of the band spectrum type with an unusually wide spacing between individual lines of a band. These bands arise, or at any rate can be formally represented as arising, from a change in configuration of the molecule whereby both its internal energy and its rotational energy are altered. It frequently happens, owing to the operation of a selective principle that such changes are restricted to changes in which the rotational quantum number either increases by unity, diminishes by unity, or stays constant. If all these types of change are possible in connection with the same change of internal energy, three associated bands or series of lines arise, which are termed P, R, and Q series respectively. The value of the initial moment of inertia is found to be $J_1 \times 6 \cdot 2415 \times 10^{-41}$ gm. cm.^{2} and that of the final moment $J_2 = 4 \cdot 7979 \times 10^{-41}$ gm. cm.^{2}. These values are much higher—in fact, about three times as high as the corresponding quantities when deduced from Fulcher's bands, which are of the order $1 \cdot 8 \times 10^{-41}$. The values of the moments of inertia of the helium molecule found by Curtis lie between the limits $1 \cdot 7 \times 10^{-40}$ and $1 \cdot 9 \times 10^{-40}$. The present values are about half-way between these hydrogen and helium values. This suggests that the lines discussed in this paper are due to an abnormal hydrogen molecule, such perhaps as H_3, rather than to excited forms of H_2, an inference which is also supported by the distribution of intensity among the different lines. Further investigation to settle this point is necessary. A. E. G.

849. *Displacement Law for Arc and Spark Spectra.* **W. F. Meggers, C. C. Kiess** and **F. M. Walters, Jr.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 355–374, Oct., 1924.)—The spark spectrum of every element resembles the arc spectrum of that which precedes it; and the spectra are characterised alternately by odd and even structure. These two laws are ascribed to the alternately odd and even numbers of electrons in the outer (valency) orbits. Until recently they rested on evidence from the first three groups. This paper presents the results of work at the Bureau of Standards on the spark spectra of the fourth row of elements. Some multiplet structures are therefore given in detail for Sc^+, Ti^+, V^+, Cr^+, Mn^+, Fe^+, those for Ca^+ being already known. A. C. M.

850. *Distribution of Electric Field in Metal Arcs and the Stark Effect Observed in Arcs of Various Metals.* **H. Nagaoka** and **Y. Sugiura.** (Japanese Journ. Phys. 3. No. 1–3. pp. 45–73, 1924. In English.)—The study of the small variations in wave-lengths of light emitted in the neighbourhood of the electrodes of various metals leads to investigation of the so-called pole effect. The effect must be attributed to a combination of different causes, such as the pressure effect, the Doppler and Stark effects, and to a small extent the Zeeman effect of the magnetic force of the arc current. The pressure effect is in itself a very complicated phenomenon the true nature of which is still difficult to elucidate. On estimating the relative importance of these effects it is seen at once that changes in wave-lengths along the arc must be due mostly to electric force, as the field is not at all uniform and shows great variations near the electrode. The arc, when lighted at ordinary voltages, is not always steady, but shows fluctuation which cannot be easily controlled, and thus the measurement of the field along the arc is rendered extremely difficult. The present method of using a stabilised arc opens a convenient means of studying the Stark effect of different elements with a simple spectroscope, and with short exposure in photographing. The similarity in the effect of the electric field on lines belonging to the same series, and the increase of the effect with term number is analogous to Preston's rule in the Zeeman effect. The sorting of lines according to different types of the effect, especially in elements, as iron, molybdenum, tungsten, and others, having a large number of lines promiscuously mixed together, can be made by simple inspection of the photograms from which the series lines, which only appear by the application of strong fields, can also be found. Further investigation is necessary to vary the field of the double layer at the electrodes, as it differs according to the nature of the metal. Metal arcs can be stabilised by introducing capacity of over 1μF. and large self-inductance between the electrodes, and the length greatly increased by using 500-volt d.c. generator, by which an arc of 7 cm. length can be steadily maintained with carbon as kathode and metal as anode. Oxide-covered carbon is preferable for intense arcs. The potential drop along the arc is examined. The arc is similar to a vacuum discharge in these respects. Electrodes are the seats of strong electric field due to the presence of an electric double layer, which is formed when the current surpasses a critical value. The form of the arc is swayed by Maxwellian stress. For obtaining Stark effect, a small drop of metal at the anode is preferable. In different metals, fields of 20×10^4 to 6×10^4 volts/cm. are obtained. In Ag, Cu, Mg, Zn, Cd, and Al lines belonging to the same series are similarly affected, and the nature of the change is different according to series, the effect increasing with the term number. In iron, six types of change in electric field are noticed; most of the lines thus affected belong to spark lines, while the arc lines remain generally unaffected. The effects thus observed by simple arrangement can be utilised for sorting the lines in a manner similar to Preston's rule in Zeeman effect. Many new lines are observed which are presumably due to the presence of strong electric field at the anode. A. E. G.

851. *Pole Lines Occurring in the Interrupted Arc Spectra of Silver, Gold, and Copper.* **H. Lowery.** (Phil. Mag. 48. pp. 1122–1131, Dec., 1924.)—During an investigation on the Stark effect in the arc, the spectra of "arc flashes" between silver, gold, and copper poles in air, hydrogen, and oxygen were photographed. In this paper certain lines which seem to be associated with the lower pole of the arc under the particular conditions of the experiments are investigated. The method of making an arc flash is that used by Hemsalech and de Gramont [see Abstract 1295 (1922)]. It is found that in the region studied, λ5220 to λ3380, a number of lines occur in the neighbourhood of the fixed pole which readily fall into two classes according as they cease abruptly at the end of the initial stages of the arc flash or tend to pass on into the intermediate and final stages. Most of the lines have been identified with previously observed arc and spark lines, but a number of them do not seem to have been previously recorded. Lists of the "new" lines occurring in the region λ5220 to λ3380 of the spectra of the interrupted arcs between silver, gold, and copper poles are given, as is also a photograph of the spectrum of an interrupted arc between silver poles. A. E. G.

852. *Regularities in the Arc Spectrum of Columbium.* **W. F. Meggers.** (Washington Acad. Sci., J. 14. pp. 442–446, Nov. 19, 1924.)—Investigation confirms that the structure of the columbium spectrum possesses similar structures to that of vanadium, but it is impossible to make the analysis of the columbium spectrum as complete as that for vanadium. The regularities in the sextet system are tabulated, and also the Zeeman effect. W. A. R.

853. *Higher Order Spark Spectra of Argon, Krypton, and Xenon.* **L. and E. Bloch and G. Déjardin.** (Ann. de Physique, 2. pp. 461–505, Dec., 1924.)—The method previously described (electrodeless discharge, the voltage being controlled by a movable spark-gap) and applied to the sorting-out of the mercury lines into 1st spark, 2nd spark, 3rd, and higher spark categories, has now been used for a similar discrimination in the above-named gases.

The results indicate that they possess 1st, 2nd, and 3rd spark spectra which are at present all confused as " blue " spectra. The tables given contain many new lines. [See Abstract 1471 (1924).] A. C. M.

854. *Spark Spectral of Iron in the Schumann Region.* **L. and E. Bloch.** (Comptes Rendus, 179. pp. 1396–1399, Dec. 15, 1924.)—Following up previous work [see Abstracts 1067 and 1068 (1921)] the authors now publish a list of 253 wave-lengths, more than half of which are new. E. H. B.

855. *The Spectrum of Germanium.* **J. Lunt.** (Roy. Astron. Soc., M.N. 85. pp. 38–46, Nov., 1924.)—The spectrum of germanium is photographed using germanium tetrachloride in vacuum tubes, and the lines are tabulated and compared with the arc lines. Remarkable temperature shifts are noted. New lines due to chlorine are also obtained. A. Wh.

856. *Temperature Displacements in the Spectra of Germanium and Chlorine.* **J. Lunt.** (Roy. Astron. Soc., M.N. 85. pp. 148–156, Dec., 1924.)—The spectra of germanium tetrachloride in vacuum tubes are investigated and it is shown that temperature shifts of the lines can be observed by working with various intensities of discharge which are greatly in excess of any temperature shifts hitherto observed. Thus for the two red lines of germanium there is an observed shift between the limits of the conditions of 1·5 and 1·6 Å.U. towards the red for the higher temperature. In the chlorine spectrum there seem to be two well-defined groups of lines, one of which is subject to temperature displacement while the other is not. It is suggested that the interpretations of a good many astrophysical observations may have to be reconsidered since the Doppler velocities and pressures which have been deduced are not always at all satisfactory. A series of notes on previous work on temperature shifts is given, as well as tables of wave-lengths and temperature shifts of chlorine lines and reproductions of plates showing them. A. Wh.

857. *The Extreme Ultra-Violet Spectrum of Germanium and of Scandium.* **H. J. C. Ireton.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 103–109, 1924.)—Investigation was made of the ultra-violet spectrum of germanium below 2138·7 Å., the shortest recorded wave-length for this element, while scandium was investigated beyond 2233·7 Å. The materials used were pure oxides of the elements compressed with aluminium into rods which served as electrodes. The spectra from 2300 Å. to 1854 Å. were obtained from sparks in air, but below 2000 a vacuum grating spectrograph was used. Tables of observed wave-lengths are given. The final results extend the spark spectrum of germanium from 2138·7 Å. to 319·7 Å., 64 lines being recorded, while the spark spectrum of scandium has been extended from 2233·7 to 507·1 Å., 45 lines being recorded. W. V. M.

858. *The Electric Furnace Spectra of Vanadium and Chromium in the Ultra-Violet.* **A. S. King.** (Mt. Wilson Observat. Contrib. No. 283. Astrophys. J. 60. pp. 282–300, Dec., 1924.)—This paper supplements Abstract 690 (1915), which covered these spectra from the foregoing limits into the red. Temperature stages of 2000°, 2300°, and 2600° C. were employed to observe the initial appearance and rate of increase in intensity of the ultra-violet lines to about λ2700, while for shorter wave-lengths the absorption furnace was compared with the arc. The tables give the temperature classification of 515 vanadium and 640 chromium lines and their relative intensities in arc and furnace. New wave-lengths are given for 133 vanadium and 94 chromium lines which have not been measured in the arc spectrum or for which, owing to diffuseness or blends, the previous wave-lengths are poor. Comparison photographs of the spark spectrum were made for the selection of enhanced lines. Many enhanced lines of vanadium are emitted by the furnace, while those of chromium require, for the most part, the higher excitation of the arc for their initial appearance. In the *Discussion*, mention is made of notable groups of low-temperature and high-temperature lines, also of the phenomena of reversal and dissymmetry in the condensed spark.

AUTHOR.

859. *Double Excitation Spectra of Magnesium and Related Elements.* **J. B. Green** and **M. Petersen.** (Astrophys. J. 60. pp. 301–312, Dec., 1924.)—The group of five strong lines at about 2780 Å. in the spectrum of Mg are known to be Zeeman triplets of 3/2 normal separation, and constitute a group $1p_i - mp_i'$. Since their occurrence in the spectrum is found to have no correlation to the strength of the spark spectrum, it is argued that the origin of the p'-terms cannot be related to the ionised state of the atom. The wave-lengths of the group have been measured in arc, in vacuum, and in air, and show a shift to red in air. A line, probably $1p_1 - 4s$, was separated from the pp'-group and measured. The line 4380 Å. was measured and given the assignment $1P - mp_1'$. The lines 2768 Å. and 2765 Å. are found to be accompanied by a third, making a complete $1p$-triplet, whose variable term is in question. The p'- and d'-terms of Mg and the other alkali earths are proposed as designating doubly excited states of the neutral atoms independent of metastable ionised states. Corresponding to these triplet terms, Saunders' singlet terms—mX, mY, mZ—are suggested as doubly excited singlet states. The evidence relating to these proposals, as found in the conditions of excitation of the primed terms, is presented.

AUTHORS.

860. *The Influence of Temperature on the Absorption Spectra of Borax and Phosphate Beads.* **Marguerite Funck.** (Zeits. wiss. Phot. 23. pp. 73–78, Dec., 1924.)—The earlier spectroscopic researches of Conroy, Rizzo, Königsberger, Houston, J. Becquerel, T. Retschinsky, and so on, upon the influence of temperature on the absorption spectrum of a solid, makes it appear probable that, with increasing temperature, a certain absorption band is widened and displaced towards the red with an increase of its maximum, while with a decreasing temperature the corresponding reverse takes place. It seemed to be advisable, therefore, to carry out some experiments upon materials which are known to have an especially strong dependence of spectral absorption upon temperature, hence borax and phosphate beads are chosen for the present experiments. From the results obtained it is concluded that an increasing temperature produces strong modifications of the absorption spectra without constitutive alteration of the absorbing complexes. The modifications include the position of the bands but not of the "structure" of the absorption spectra.

A. E. G.

861. *Kathode Spectra of Metals and their Salts.* **M. Kimura** and **G. Nakamura.** (Japanese Journ. Phys. 3. No. 1–3. pp. 29–41, 1924. In English.)—In general the spectrum emitted by a Geissler tube is that of the residual gas and not that of the metal electrodes. In certain cases, the metallic lines can be observed, especially when nitrogen is the residual gas. The metallic spectra have also been observed when a salt of the metal is bombarded by canal rays. In the present case a platinum wire was sealed into the neck end of a small flask in which the salt to be examined was placed and formed the kathode, while the anode was contained in a side tube. The spectra were photographed with a Hilger constant deviation spectrometer and camera. Results are given for the following metals: Li, Na, Cu, Mg, Ca, Zn, Sr, Cd, Ba, Sn, Pb, Bi. It was found that the side-way emission could also be observed in some cases by using a metallic kathode and a halogen salt of the metal as anode. Such observations were made in the cases of Sn, Pb, and Cd, and it was found that the lines were emitted chiefly in the dark space in front of the kathode where the electric field was very strong. It is shown that the end-on kathode spectra of Mg-, Sn-, and Pb-salts present a spark character, those of Zn-, Cd-, and Bi-salts an arc character, while those of Ca-, Sr-, and Ba-salts show neither characteristic, but give only a few lines of their spectra. F. S.

862. *Kathode Spectra of Metals.* **M. Kimura** and **G. Nakamura.** (Japanese Journ. Phys. 3. No. 1–3. pp. 43–44, 1924. In English.)—A continuation of the work described in the preceding Abstract. The kathode spectra of Cd, Al, Zn, and Pb were photographed with a Hilger quartz spectrograph, an image of the glow in front of the kathode being projected on to the slit by means of a quartz-fluorite lens. Both arc and spark lines were strong at the surface of the kathode, but the spark lines decreased more rapidly with distance from the kathode. In an ordinary spark spectrum the longer spark lines have greater intensity than the shorter ones, being attributed to the singly ionised atom and the latter to a doubly ionised atom. F. S.

863. *Structure of the Lithium Red Line* $\lambda = 6708$ Å. **D. S. Ainslie.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 137–143, 1924.)—A continuation of previous work by McLennan and the author [see Abstract 2409 (1922)], who observed the line as a quadruplet with separation between the components of 0·128, 0·173, and 0·165 Å. respectively. A vacuum arc lamp was used in which the positive terminal was a carbon cup containing lithium metal or salt and the negative a solid carbon rod, the arc being struck by a copper rod. The simple doublet pattern was obtained with arc currents of from 4 to 6 amps. With slightly greater currents the shorter component divided, thus giving a triplet pattern, while at about 7 amps. both components appeared doubled. Reproductions of these appearances as observed with an echelon grating and with a Lummer plate are given and also measurements of separation. A number of well-marked absorption bands were observed in the spectrum of lithium metal between $\lambda = 4132$ Å. and $\lambda = 3232$ Å., and their wave-lengths are given. F. S.

864. *Intensities in the Argon Spectrum.* **P. Lowe** and **D. C. Rose.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 313–323, 1924.)—This is an extension to argon of previous work on hydrogen and helium [see Abstracts 266 and 267 (1924)] in which the intensity was studied as a function of the energy of electrons impinging on the gas and producing radiation. The apparatus was the same as in previous work and intensities were measured by a neutral wedge. Three methods were adopted to measure the length of lines. The first was the enlargement method of Merton and Nicholson, but as this is a somewhat lengthy process two others were substituted. The first of these was a micro-photometer with a tiny filament in the eyepiece, the brightness of which is used to determine the peak of the line, the height being measured by a micrometer screw. The last method was to use a low-power microscope to measure the length of line. This yielded better results than had been expected, variations of less than 3 % being obtained in relative measurements. Curves are given showing the change in photographic intensity with increase in accelerating voltage for various representative lines. The shapes of these curves lead to certain classification of the lines, the first great division corresponding to the red and blue spectra. The former is visible at all voltages, while the latter begins to appear slightly below 40 volts. The red spectrum is further divided into two groups and one of these groups into two sections. The first group contains lines classified by Rydberg, and the second a number of lines which have been fitted to a formula of the Ritz type by Nissen. **F. S.**

865. *The Series, Ultra-Violet and Infra-Red Spectra of Silicon.* **J. C. McLennan** and **W. W. Shaver.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 1–22, 1924.)—The extreme ultra-violet spectrum of the silicon vacuum spark has been investigated in the region between λ2000 Å. and λ458 Å. The observations disclosed the existence of 50 new lines not given by Millikan, and their wave-lengths and frequencies were calculated and tabulated. Further 21 lines belonging to the Si IV series spectra, as worked out by Fowler, were recorded on the vacuum spark spectrograms, 8 of which had not previously been observed. The near ultra-violet spectrum (λ2300 Å. to λ1842 Å.) of the Si arc and spark in air was investigated with a quartz spectrograph and a considerable number of new lines found, the frequencies and wave-lengths being calculated and tabulated. The Si vacuum arc spectrum was studied with a fluorite spectrograph between λ1850 Å. and λ1500 Å. and for the lines observed the same calculations were made. The Si I spectrum was next examined for series relations. A scheme of constant frequency differences was worked out and energy levels accounting for a number of the Si I lines were calculated. Finally the infra-red spectrum was investigated between the limits λ6300 Å. and λ11235 Å. resulting in the detection and measurement of 33 new wave-lengths. **R. S. R.**

866. *The Extreme Ultra-Violet Spectra of the Alkali Metals.* **W. W. Shaver.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 23–34, 1924.)—A number of experimenters have investigated the spectra of the vapours of Na, K, Rb, and Cs with the electrodeless discharge in the visible and near ultra-violet regions. The object of the present investigation was to extend the study of these enhanced spectra in the extreme ultra-violet by means of a fluorite vacuum spectrograph in order to make additions to the lists of wave-lengths available for series analysis. For the work with Rb and Cs in the quartz region a small Hilger quartz spectrograph specially adjusted for the ultra-violet region was used. The discharge chamber was mounted in an electrical furnce and the temperature was raised until the electrodeless discharge produced a bright glow in the bulb. Of the four metals investigated K alone gave a strong spectrum in the fluorite region extending to the wave-length λ1602·2 Å. The frequencies and wave-lengths of the lines were calculated and recorded. The spectra of the electrodeless discharge in the vapours of Rb and Cs were also studied in the region between λ1850 Å. and λ2300 Å. and a number of lines in addition to those found by Dunoyer were observed and their frequencies and wave-lengths determined. A number of frequencies were found on the K spectrum to agree well with two series lines predicted by Nissen, and others that agreed within the experimental error with certain energy levels calculated by Nissen for the singly-ionised K atom. R. S. R.

867. *The Absorption and Series Spectra of Tin.* **J. C. McLennan, J. F. T. Young** and **A. B. McLay.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 57–75, 1924.)—The tin arc spectrum has been remeasured from λ2251 Å. to λ1850 Å. and many new wave-lengths added to the list. The absorption spectrum of normal tin vapour at about 1200° C. has been extended to include 17 lines, and 40 new wave-lengths have been added to the tin arc spectrum in the Schumann region by employing an arc reversal method with an atmosphere of hydrogen. A comprehensive table of groups of constant frequency differences has been compiled for the tin arc spectrum and from the reversal experiments six limits have been defined in the tin arc spectrum. The sharp and diffuse subordinate series arising from these limits have been established. The ionisation potential is evaluated at 7·3 volts whilst the resonance potential is given as from 4·3 to 4·8 volts. Interesting groups in the infra-red region of the tin arc spectrum are discussed. The paper is illustrated by actual photographs and the results embodied in a series of concise tables. S. G. B.

868. *The Absorption and Series Spectra of Lead.* **J. C. McLennan, J. F. T. Young** and **A. B. McLay.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 77–88, 1924.)—The paper correlates the various data regarding the lead arc series. The Thorsen-Grotrian scheme for the lead arc series spectrum is criticised and by recalculation of the term values it is transformed to vacuum frequencies. New lines are recorded by a remeasurement of the lead arc spectrum from λ2250 Å. to λ1850 Å. Twelve new wave-lengths were added to this region by the photographing of the arc reversal spectrum of the lead arc in hydrogen. Nineteen anticipated combinations on the basis of the Thorsen-Grotrian scheme were established. The validity of many terms was confirmed and the results generally tend to confirm and extend the Thorsen-Grotrian arrangement of the lead arc series. Tables are given. S. G. B.

869. *Structure of the Mercury Line* 4358. **Rita Brunetti.** (N. Cimento, 1. pp. 277–281, Oct.–Nov.–Dec., 1924.)—The data on the structure of this line given by the author using the same method as employed for the analysis of 5461 [Abstracts 1482 and 2918 (1924)] are tabulated with experimental results by Wood, Nagaoka and Takamine, and Nagaoka. Comparison of the components leads to the conclusion that there is a central component which is the most sensitive to absorption and inversion. The sensitivity to absorption falls off symmetrically on each side and there is a considerable difference in the absorption in the central and lateral groups of satellites. A. Wh.

870. *Band Spectrum of Aluminium Hydride.* **W. Mœrikofer.** (Arch. des Sciences, 6. pp. 401–404, Nov.–Dec., 1924. Paper read before the Soc. Suisse de Physique, Oct., 1924.)—Besides the series of doublets and isolated lines, the arc spectrum of aluminium contains two band spectra which are not related. One always appears, while the other is observed under certain conditions only as several bands in the blue and violet degraded towards the red. They appear in air at reduced pressure or in hydrogen at atmospheric pressure, and attain considerable intensity in the neighbourhood of the poles with a current of 8 to 10 amps. They have been previously studied by a number of American workers [see Abstract 416 (1913)], but the author has extended the measurements from 73 to 131 bands. The bands are attributed to aluminium hydride on account of the conditions of excitation mentioned and also because the interval between the lines in a band suggests that the moment of inertia of the emitting molecule is small. The bands are only completely developed when iron is shown to be absent from the aluminium electrodes. Contrary to most band spectra, the laws of grouping of the lines are very complicated. F. S.

871. *The Secondary Spectrum of Hydrogen at Very Low Temperatures.* **J. C. McLennan** and **G. M. Shrum.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 177–185, 1924.)—The problem of the variations in intensity in the secondary spectrum of H_2 has been dealt with in a simplified way, for the atomic and molecular processes involved, with the aid of low temperatures. The distribution of intensities thus becomes a function of a single fundamental variable. Reproductions are given of the H_2 spectra photographed at room temperature and − 252° C. and tables show the respective lines enhanced or weakened at this low temperature. The effect of this temperature on the number of molecules in the lower and higher quantum rotational states and the bearing of the results obtained, on those of Allen [Abstract 2768 (1924)] are discussed. R. S. R.

872. *An Effect of Argon on the First Positive Band Spectrum of Nitrogen.* **R. C. Johnson.** (Phil. Mag. 48. pp. 1069–1074, Dec., 1924.)—The author first discusses the results of other investigators, including Strutt and Fowler, Rayleigh, Steubing and Toussaint, on the modifications of the first positive band spectrum of nitrogen under various conditions of excitation. He proceeds to describe the results of observations made whilst working with tubes containing argon imperfectly purified, *i.e.* with a trace of nitrogen, the effects being similar to an afterglow. The first positive band spectrum was found to be considerably modified in the case of traces of nitrogen in high-pressure argon. This spectrum was found to consist in a selection of a few only of the band heads of the various groups, and the general effect was similar to that found in the afterglow spectrum. Quantitative investigations are described which indicate that there is an energy displacement towards the more refrangible end of each band group. This is also similar to the conditions of the afterglow. It suggests that all the phenomena hitherto regarded as peculiar to the electric conditions obtaining in the afterglow may be reproduced in high-pressure argon. The bearing of these facts on the nature of the afterglow spectrum is discussed. The paper is illustrated with spectrum and wedge photographs of argon nitrogen mixtures. [See also Abstracts 1146 (1923) and 1177 (1924).] A. W. J.

873. *On the Characteristic X-Rays from Light Elements.* **(Miss) M. Levi.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 159–176, 1924.)—During recent years a number of workers have studied the long-wave absorption limits of various elements. The method used consists essentially of exciting the radiation by bombarding the element under consideration with electrons of increasing energy, the resulting radiation being measured by its photoelectric reaction on an insulated metal electrode. On plotting the photoelectric current against the voltage, curves were obtained showing marked discontinuities, the voltages at which these discontinuities appear being interpreted as the quantum equivalents of the convergence frequency of one of the X-ray series. By adopting this method the writer was enabled to determine the critical K and L absorption limits of a series of elements, the results being given below. By using a high vacuum and eliminating errors due to ionisation of the residual air definite and consistent results were obtained. The observed values are as follows:

K series..Li 263A ; Be 116A ; B 85A ; C 42A ; O 25A.

L series..Li 1473A ; Be 685A ; B 500A ; C 352A.
F 195A ; Na 304A ; Si 87A ; Cl 55A.
Sc 23A ; Ti 20A ; Va 21A ; Ni 16A.

M series..Cl 507A ; Sc 295A ; Ti 148A ; Cr 203A.
Mn 184A ; Co 134A ; Co also 52A.
Ni 35A ; 120A ; 161A and 232A.

These values were used to plot the Moseley graph for the elements of low atomic number. From Li to F the limits lie considerably above the predicted line, a result in agreement with previous observers. The abrupt falling away from the upper course of the L line supports the view that a decided change in the L electronic layer takes place as we pass from Na to F. In the M series the observed values for elements between Fe and Zn lie midway between the L and M lines. The results are not sufficiently accurate to distinguish between various levels of one electronic layer. Si, Cr, and Mn show a decrease rather than an increase in the total radiation above the critical voltage. W. V. M.

874. *Continuous X-Ray Spectra and Planck's Radiation Law.* **A. March.** (Ann. d. Physik, 75. 7. pp. 711–742, Dec., 1924.)—The number of experimental investigations on the continuous background of X-radiation is small and in general the actual observations are, for various reasons, in error. The paper, which is largely mathematical, is an attempt to work out the idea that the continuous background is essentially a heat radiation, which is sent out from atoms of the antikathode strongly heated by collision with electrons; that is, Planck's law can be applied in this region. The preliminary considerations of the question show that the distribution of energy in the continuous spectrum is similar to that in the heat spectrum. A useful account is given of the experimental investigations of this intensity distribution and its dependence on such factors as voltage and atomic number of the element of the target. General expressions are obtained for the distribution of electrons with respect to direction and energy when a stream strikes the target, the total radiation being computed by the aid of Sommerfeld's formula for the radiation from a single accelerated electron. The expression involves N, λ, λ_0, n where N = number of collisions per electron before it is brought to rest, λ_0 = wave-length of the end radiation, n = the index of ν which determines the probability of radiation as dependent on the frequency, etc., $\omega = \kappa\nu^n$. N and n are determined from the size of the "knick" at the end of the straight line found experimentally to represent the relation between J_γ and γ, where J_γ = energy in the spectrum in a small region $d\nu$ of frequency ν. N is actually equal to 5 approximately. n is obtained from the consideration of Duane and Hunt's law that the total energy is proportional to the square of the voltage. $n = 1$, in opposition to the law holding in the region of heat radiation where $n = 2$. Hence using these values fair agreement is obtained with the observed experimental distribution of intensity. Employing Wren's law and the observed $\lambda_{\max.}$ [in the ordinary notation], then the temperature is of the order of 160×10^6 degrees absolute. W. V. M.

875. *Effects of Working of Metals upon X-Ray Spectrum.* **E. Schiebold.** (Zeits. f. Metallkunde, 16. pp. 417–425, Nov., and pp. 462–481, Dec., 1924.)—The work on the effect of rolling and drawing metals is reviewed, and the variation of the X-ray spectrum caused by elastic deformation is shown. It was shown that when a plate of mica was bent the points on the X-ray photograph were displaced. Similar displacement was found when aluminium was rolled or drawn. The various aspects of the plastic deformation of metals, and the effect on the X-ray spectrum is discussed, and many photographs illustrating the influence of deformation on the photograph, are given. F. J. B.

876. *Secondary Electrons Produced by Hard X-Rays in Light Elements.* **H. Fricke and O. Glasser.** (Nat. Acad. Sci., Proc. 10. pp. 441–447, Nov., 1924.)—Compton [see Abstract 2194 (1923)] has recently proposed a theory for the scattering of X-rays which successfully explains many of the phenomena which depend on the interaction between light atoms and hard X-rays. A corollary of this theory consists in the prediction and quantitative description of a special type of secondary electrons which result from the passage of X-rays through matter. The actual existence of these electrons which Compton terms *recoil-electrons* has been demonstrated by C. T. R. Wilson [Abstract 2213 (1923)], according to whom the range and number of recoil-electrons of varying hardness is in fair agreement with Compton's theory. In the investigation now described the authors give details of an experimental determination of that fraction of the ionisation of X-rays in air for which the recoil-emission is responsible, offering thereby an indirect determination of the absorption due to the recoil-electron emission, the value for which is given by Compton's theory. A. B. W.

877. *Oil Immersed X-Ray Generating Outfits and their Uses.* **W. D. Coolidge.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 653–673, Dec., 1924.)—The subject-matter of this lengthy and well illustrated article

has already appeared in patent specifications of X-ray apparatus, in which the X-ray tube is actually immersed in the oil of the transformer tank. The advantages of such a method of mounting, as protection against electrical shock, radiation, etc., have already been fully discussed in radiology papers in general. The applications of this method in practice are shown applied to portable and dental X-ray apparatus, as well as applied for scientific purposes, such as the Millikan oil-drop experiment, the Wilson ray track experiment, the Laue diffraction experiment, etc.

The X-ray self-rectifying tube used is a very small type of Coolidge tube about 4 in. in length, the glass container of which is lead glass with a lime-glass window.

An oil-expansion chamber of " Sylphon " metal to control the expansion of the oil and the " Kearsley " stabiliser are fully described.

Whilst the apparatus described covers no new features other than designs already covered by patent specifications, the article summarises various recent patents of Coolidge and the American G.E.C. B. J. L.

RADIO-ACTIVITY.

878. *The Radio-Active Constant of Radon.* **Irène Curie and (Miss) C. Chamié.** (J. de Physique et le Radium, 5. pp. 238–248, Aug., 1924.) —The radio-active constant of radon has been redetermined by a method which depends on the fact that if two identical quantities were allowed to decay until the two together were exactly equivalent to the initial value of one, the interval that must elapse must be exactly the half-change period. In this way the authors have obtained the value T = 3·823 days as compared with the value T = 3·825 days recently given by Bothe. **Erratum.** (Ibid. p. 384, Dec., 1224.) T. M. L.

879. *Decay of Radium Emanation.—Constancy of Rate for Different Concentrations.* **(Mme.) P. Curie** (Ann. de Physique, 2. pp. 405–433, Nov.–Dec., 1924.)—The object of the investigation was to discover if the decay constant of RaEm is the same for very strong as for very dilute preparations. It is suggested that a change of the decay constant may be produced by the effect of α-ray collisions in the emanation as well as a possible effect of a similar nature due to the β and γ rays—such effects would be perhaps more noticeable in concentrated than in dilute preparations of emanation. The experiments described consist essentially in the comparison, by a very sensitive compensation method, of the decrease of γ-activity of two almost equal quantities of RaEm (approx. 200 millicuries each), one of which is enclosed in a small sphere having a volume of 0·2 mm.^{3}, whilst the other is enclosed in a closed capillary having a volume of several mm.^{3}. The theoretical conditions of the experiment are examined in some detail, having regard also to the conditions for obtaining high precision. It has been proved that for similar preparations of RaEm the rate of decay is the same, within 1 part in 10,000. The comparison of the small spherical source (under a partial pressure of 0·5 atmosphere) with that of larger volume has indicated a difference of rate of decay not exceeding 1 part in 2000. To decide whether this small difference is a real effect due to the cause suggested at the commencement of the paper, a further investigation is contemplated. The experiments indicate, however, that it is possible to compare preparations of RaEm with an accuracy of 1 in 10^4. A. B. W.

880. *Natural and Artificial Disintegration of the Elements.* **E. Rutherford.** (Frank. Inst., J. 198. pp. 725–744, Dec., 1924.)—A review of recent investigations bearing on the question of the structure of the nuclei of atoms. The paper deals mainly with the work of the author relating to this question, referring briefly to his researches on the following: (1) Dimensions of the nuclei of atoms, and the law of force. (2) Radioactive evidence regarding the natural modes of disintegration of atoms. (3) Frequency of vibration of the nucleus as evidenced by γ-ray emissions. (4) Artificial disintegration of elements by α-particle bombardment. (5) Velocity of escape of hydrogen nuclei. (6) General remarks regarding the evolution of the elements from positive and negative electrons. The original paper should be consulted if details are required. A. B. W.

881. *γ-Radiation of Great Energy of the Active Substances of the Thorium Family.* **J. Thibaud.** (Comptes Rendus, 179. pp. 1052–1054, Nov. 17, 1924.)—The natural β-ray spectra of ThB, ThC, and ThC″ have been studied by Ellis, Hahn, and Meitner, who attributed the intense lines to a certain number of γ-rays of energy less that 600 kilovolts. The present author has used the method previously employed [Abstract 379 (1925)], and succeeded in identifying γ-rays of greater energy. Thus various substances, such as Ur, Pb, Pt, W, Sn, and even Ag, were exposed to the source to be studied (a thin-walled sealed glass tube containing mesothorium in equilibrium with its active products) and the excited β-ray spectra studied. De Broglie and Cabrera [see Abstract 1597 (1923)] have found, using a similar source, γ-rays having energies up to 426 kilovolts, but the author has shown the existence of rays of greater energy, in particular the β-ray spectra from Pb (isotope of ThB) shows corpuscular rays having energies up to 873·5 kilovolts. All rays with one exception emanate from the *k* levels, and γ-rays having energies of 580·7, 795·2 (feeble), 908·2, 962·7 kilovolts respectively are deduced. The first of these (580·7) has its origin in ThC″, while 908·2 and 962·7 might be attributable to mesothorium 2, but their origin is doubtful. No continuous γ-ray spectrum is observed between 700 and 2000 kilovolts. W. V. M.

882. *The Penetrating γ-Radiation of Mesothorium 2.* **J. Thibaud.** (Comptes Rendus, 179. pp. 1322–1324, Dec. 8, 1924.)—A continuation of the work described in the preceding Abstract. The origin of the lines 908·2 and 962·7 is definitely confirmed to be mesothorium 2 and three feeble β-ray lines are found for a lead radiator, one of which agrees with previous work by de Broglie and Cabrera [Abstract 1597 (1923)]. Thus, extending the previous conclusions, four characteristic lines of the γ-ray spectrum of mesothorium are obtained having energies of 333, 459, 908·2, and 962·7 kilovolts respectively. Thus for this source, as well as for RaB and RaC, the natural β-ray spectrum appears to be a secondary effect of the γ-radiations. W. V. M.

883. *The Theory of the Decay of Alpha-Ray Luminescence.* **E. E. Witmer.** (Phys. Rev. 24. pp. 639–643, Dec., 1924.)—The Walsh equation for the decay of luminosity in substances which luminesce under α-ray bombardment, $I = I_\infty + I_0 e^{-\lambda t}$ is modified by introducing the additional assumption that the field of radiation due to the decay of the active centres reacts on the centres in the inactive state and forms new active centres by reversing the decay process. The new equation

$(I - I_\infty)/(I + I_1) = Ce^{-\lambda t}$ fits data obtained by Miss F. Rodman [Abstract 1504 (1924)] for the decay of luminosity of c.p. radium bromide, which the Walsh equation does not. It is only approximately correct when the radiation effect is small. The exact equation developed on these assumptions, which is more complicated, is also given. For a mixture of radium bromide and barium bromide the data are well represented by the sum of two time luminosity curves with equations of the less exact type. AUTHOR.

884. *Number of β-Particles from Radium-E.* **K. G. Emeléus.** (Cambridge Phil. Soc., Proc. 22. pp. 400–404, Sept., 1924.)—With the help of an electrical counter measurements have been made of the numbers of α- and β-particles from a source of radium-D, E, and F, the last two being in equilibrium. After correction for the reflection of β-particles at the source, the numbers of the two kinds of particles are about equal. According to the results of previous work on their absorption, the β-particles from radium-D would not be recorded under the experimental conditions employed by the author. On this assumption the observed β-radiation is due to disintegration of radium-E, and as the latter is in equilibrium with radium-F, it follows that about one β-particle is emitted per disintegrating atom of radium-E. T. H. P.

885. *The Radium-Emanation Content of Sea Air from Observations Aboard the "Carnegie," 1915–1921.* **S. J. Mauchly.** (Terrest. Magn. 29. pp. 187–194, Dec., 1924. Paper read before the Am. Phys. Soc., Dec., 1924.)—Observations for determining the radio-active content of the air have been regularly made aboard the yacht *Carnegie*, when at sea, since 1909. From 1909 to 1914 the Elster-and-Geitel method was used, and the results obtained have been published elsewhere. Since 1915 observations for absolute determinations have been made aboard the vessel using an adaptation of the Gerdien aspiration method. A summary is given of the final results of nearly 400 observations for the period 1915 to 1921, showing in considerable detail the distribution of radium emanation over each of the major oceans. The mean value of the radium-emanation content over the oceans resulting from all the observations is $2 \cdot 6 \times 10^{-18}$ curies per cubic centimetre. However, if observations which clearly show the effects of nearby land are excluded, the mean value of $1 \cdot 2 \times 10^{-18}$ curies per cubic centimetre is obtained from the remaining 333 observations. These results fully confirm the earlier conclusions of Simpson and of Swann to the effect that the radium emanation normally present in sea air well removed from land is entirely inadequate for producing the atmospheric ionisation found in these regions. They do not support Bongards suggestion that an appreciable portion of the radio-active content of the earth's lower atmosphere is of solar origin. AUTHOR.

886. *A Mechanical Device for Sealing Off Radium Emanation Tubes.* **H. H. Poole.** (Roy. Dublin Soc., Proc. 17. pp. 337–339, Aug., 1924.)—Tubes holding radium emanation are usually held for convenience in the fingers whilst being sealed off. In consequence of the possible danger to the operator a mechanical device, simply built up of Meccano parts, is described and illustrated by which the tube can be rotated in the blowpipe and sealing carried out with direct handling. B. J. L.

HEAT.

887. *An Observation on the Work of Eucken and Neumann on the Knowledge of the Wiedmann-Franz Law.* **O. Feussner.** (Zeits. phys. Chem. 114. p. 320, Dec. 24, 1924.)—Consideration is given to the observation of Eucken and Neumann on the dependence of grain-size on the heat-conductivity of metals [Abstract 2991 (1924)], and a criticism is made of the conclusion that two types of heat conductivity occur, the so-called crystal- and metallic-conductivity. It is thought that a clearer explanation is afforded by considering, in the light of the Einstein-Debye theory, the heat propagation as a progressive electromagnetic wave. On passing from one medium to a second where a change of heat conductivity results, a refraction of the path of the wave and a partial reflection occur. This effect leads to the crystals from which heat is emanating possessing generally a higher temperature than those in which the heat is entering.

J. N. P.

888. *Determination of the Theoretical Force and the Co-Volume of Explosives.* **E. Burlot.** (Comptes Rendus, 179. pp. 968–970, Nov. 10, 1924.)—During the combustion of an explosive in a closed vessel a determination is made of the reaction energy by measurement with a crusher gauge of the maximum pressure produced. These values are compared with those calculated from the formula $f = P_0V_0T/273$, where f is the energy, P_0, V_0 the pressure and volume at 0° C., T the maximum temperature during the explosion, is calculated from the heat of reaction and the mean specific heats as determined by Mallard and le Chatelier, or by Sarrau. The relation between density of loading Δ and the pressure is found to be given by the expression $p/\Delta = f + \alpha p$, where α is the co-volume. A source of error in the experimental measurements arises from the calibration of the crusher gauge, the indications of dynamic pressures differing from static pressures and being affected by the duration of the pressure. A further error is produced by the cooling of the gases through contact with the walls of the vessel. It is estimated that the first source of error may amount to a deviation of 13 % and the second to a deviation of 15 % in the opposite direction. With ballistite (50/50) giving an estimated temperature of 3138° abs., the measured value of f is 22 % higher than that calculated, and with an explosive of 86·5 % guncotton and 13·5 % nitroglycerine, giving an estimated temperature of 1848° abs., the measured value is 10 % higher. It is considered that the deviations are due mainly to inaccuracies in the values taken for the mean specific heats. J. N. P.

889. *Observations on the Communication of E. Burlot.* **H. le Chatelier.** (Comptes Rendus, 179. pp. 971–972, Nov. 10, 1924.)—It is considered that the measurements of Burlot [see preceding Abstract] indicate that in the case of explosions, the values derived by the author and Mallard for the mean specific heats require further revision. In the case of the gaseous mixtures employed, containing 50 % water-vapour, the values formerly employed are, under the conditions of the experiment, or a temperature of 1600° C. and a pressure of 3000 atms., seen to be about 10 % too high. This difference is considered to be due to the influence of the internal pressure of the gas. In accordance with the van der Waals' formula, this effect is negligible at the lower pressures and high temperatures employed in the determination of the specific heats, when the volume of a gas can be taken as a function of P/T. At lower temperatures, where the internal pressure is not negligible, the specific heat cannot be regarded as independent of the pressure. J. N. P.

890. *Propagation of Explosive Wave.* **P. Laffitte.** (Comptes Rendus, 179. pp. 1394–1396, Dec. 15, 1924.)—Following up the work on speeds of explosive waves in mixtures of explosive gases due to Berthelot and Vieille, to Mallard and le Chatelier, and to Dixon, the author seeks the experimental solution of the problem as to what happens if the explosive gases are contained in a tube which suddenly enlarges in diameter at a certain place. The result of the photographic records is that the explosive wave ceases at the place of discontinuity, that combustion occurs for a certain distance in the larger diameter tube, and that then the explosive wave reforms, the length of combustion in the second tube being greater when its diameter is greater. E. H. B.

891. *On the Thermal Expansion Coefficient of Crystalline Substances.* **Y. Endo.** (Tohoku Univ. Aeronaut. Research Inst. 1. pp. 225–246, Nov., 1924. In English.)—Starting from the compressibility formula of Born and Landé, the energy per mol at absolute zero can be calculated, and using Grüneisen's equation of state the energy of the thermal oscillations at temperature T can be also taken into account. In this way an expression is obtained for the coefficient of expansion, and the observed and calculated values, which agree fairly well together, are given for NaCl, KCl, KBr, KI, AgCl, and AgBr. If δ_m is the length of the side of the unit cell at the melting-point, and δ_0 its length at absolute zero, the values of δ_m/δ_0 are, for these six substances, 1·0311, 1·0343, 1·0359, 1·0371, 1·0211, and 1·0213. For CaF_2 α calc. $= 1{\cdot}96 \times 10^{-5}$ and α obs. $= 1{\cdot}9115 \times 10^{-5}$. In metals the author assumes that there are free electrons, situated at or near certain lattice points between the positively-charged atoms, and moving irregularly by thermal agitation. For eight metals with a face-centred lattice, assuming that the atoms and electrons are related in the same way as the metallic and halogen ions in an alkaline haloid, the observed and calculated values of α agree fairly well, and the values obtained for Madelung's constant a are nearly equal to that obtained for the alkaline haloids; it is concluded that this is the actual form of the lattice; the values of n, the exponent which characterises the repulsive force, vary from 8·0 for Cu to 14 for Au and Pt. With a body centred lattice the values of n for Fe, Na, and K are 2, 1·2, and 1·2, and of a $44{\cdot}7\,e^2$, $43{\cdot}8\,e^2$, and $45{\cdot}9\,e^2$. For Cu_2O $a = 47{\cdot}8\,e^2$, and it is concluded that the lattice structure of the above three metals is similar to that of Cu_2O, Na^{++} for example taking the place of O, and an electron the place of Cu. Diamond has the structure of zinc blende, C^{++++} taking the place of zinc and C^{----} of sulphur. In the case of copper the observed and calculated values of α at different temperatures agree quite well, though the agreement is not quite so good in the case of aluminium. H. N. A.

892. *Latent Heats of Fusion. Part II. Palmitic Acid and Benzene.* **(Mrs.) K. Stratton** and **J. R. Partington.** (Phil. Mag. 48. pp. 1085–1089, Dec., 1924.)—The latent heats of fusion, and the molecular depressions of freezing-point (with mesitylene as solute), have been determined for carefully purified palmitic acid and benzene by the method described in a former communication.

	M.Pt.	S.Pt.	B.Pt.	L gm. cal. per gm.	E for 100 grm. solvent.
Palmitic acid	62·65° C.	62·25° C.	267–270/100 mm.	51·03	43·13
Benzene....	—	5·85° C.	80·49° C.	29·92	51·39

The results remove the large discrepancy between the observed and calculated values of E in the case of palmitic acid which are given in the literature. AUTHORS.

893. *The Transformation of the Diamond in Vacuo at High Temperatures.* **P. Lebeau** and **M. Picou.** (Comptes Rendus, 179. pp. 1059–1061, Nov. 17, 1924.)—Friedel and Ribaud have recently found that diamond heated in a gaseous atmosphere is completely transformed at 1885° in less than two minutes into graphite. The authors have made experiments *in vacuo,* and find that heating for one hour at 1500° produces no change in weight or form; transparent diamonds were blackened at the edges, and the blackening could not be removed by a mixture of nitric acid and chlorate of potash; after one hour at 1800–1850° from 17·6 to 40 per cent. of the diamond (transparent or black) was transformed into graphite, which could be converted into a yellow graphitic acid by HNO_3 and $KClO_3$; but the central part remained compact, and in the transparent diamonds was not completely discoloured, some of the diamonds broke up, but not all; at 1925°, heated for one hour, the results were similar to the previous case, 6·8 per cent. of graphite was formed with one diamond and 48 per cent. with another; thirty minutes at 2000° produced a transformation of 90 per cent., some transparent fragments were isolated; in one hour at 2200° a transparent diamond and a black diamond were completely transformed. H. N. A.

894. *Measurement of Air Temperature in Closed Spaces with Thermometers not Protected from Radiation.* **H. Hausen.** (Zeits. techn. Physik, 5. 5. pp. 169–186, 1924.)—The paper is concerned with the errors introduced in the measurement of air temperature when freely exposed thermometers are used in the presence of neighbouring bodies whose temperature differs from that of the air in which the thermometers are placed. The first section is devoted to a mathematical investigation of the error, taking into account radiating bodies and thermometer bulbs of different sizes and forms. Formulæ are obtained for the "radiation error," and its numerical magnitude is evaluated for certain cases. It turns out that it may be quite large. For example, in a room, the walls of which are at a temperature of 10° C., a mercury thermometer with bulb diameter 0·55 cm., will, at a point where the air temperature is 20° C., read about 2·7° C. too low. On the other hand, in the presence of a hot surface 1 m. high and broad, with a temperature of 60° C., the same thermometer in air at 20° C. will read about 5° C. too high at 11 cm. distance from the heated surface, 2° C. at 0·4 m., and about 0·25° C. at 2 m. distance. Means of reducing or avoiding such errors are next considered. They may be considerably reduced by gilding or silvering the bulb, the reduction being considered numerically in the paper. But the most effective way (apart from using a shielded thermometer, such as an Assmann aspirated thermometer) is to use a pair with bulbs having different radiation constants, such as a plain glass one and a silvered one.

A simple formula enables the correction, which must be applied to either to get true air temperature, to be deduced from the difference between the readings of the two thermometers. Then follows a section setting out the results of experiments giving satisfactory confirmation of the theory. An appendix includes a consideration of the effect of lighting, either natural or artificial, and of the proximity of the human body when reading. Remarks are also made on the best method of exposing and supporting room thermometers. M. A. G.

895. *A Small Combustion Bomb and Micro-Calorimeter. II. Abnormal Combustions.* **W. A. Roth** and **R. Lassé.** (Zeits. Elektrochem. **30.** pp. 607–609, Dec., 1924.)—The authors have found that the micro-thermometer formerly employed by them in connection with the above apparatus [see Abstract 153 (1925)] is not really very suitable for accurate calorimetrical work, since the thread is apt to stick, and it is difficult to read to one-thousandth of a degree on account of the small-scale divisions; better results are obtained with a thermometer having a larger bulb and capillary tube. The calorimeter, with the new thermometer, was calibrated by four combustions of benzoic acid, and the water value was obtained from Henning's value for the heat of combustion of this substance, the uncertainty of the result being 0·04 per cent., and the mean deviation from the mean value 0·07 per cent. Results are given for the heat of combustion of liquid paraffin, 10,964, 10,962, and 10,969 cal. per gr., and for salicylic acid, 5241, 5245·5, 5240, and 5239·5 cal. per gr., and it is shown that the accuracy is equal to that obtained with the same thermometer with larger apparatus. Difficulties due to incomplete combustion, both in the micro-calorimeter and in larger apparatus, are discussed. H. N. A.

896. *Measurement of Heat Insulation and Related Properties of Blankets.* **P. D. Sale** and **A. F. Hedrick.** (Bureau of Standards, Technol. Papers, No. 266. pp. 529–546, 1924.)—The principal factors influencing the heat insulation of fabrics are discussed. Apparatus is described and methods proposed for the measurement of this and other related properties of blankets, *viz.*, permeability to air and water-vapour. Standard test conditions are recommended simulating those to which fabrics are subjected in service. Data illustrative of the several tests made on new blankets, typical of the variety to be obtained in the trade are presented. The heat-insulating value of blankets is correlated with thickness, weight, and density of the specimens. It is planned to supplement this paper by a following publication, *Specifications for Constructing and Operating the Heat Transmission Apparatus*, and later by a more thorough analysis of experimental data, only a part of which has been presented herein. E. G.

897. *Definition of a Perfect Gas.* **A. L. Clark.** (Roy. Soc. Canada, Trans. **18.** Sect. 3. pp. 293–311, 1924.)—The paper reviews the various thermodynamic methods of defining a perfect gas. The consequences of different methods of defining temperature are discussed. The method of defining a perfect gas depends upon the purpose in hand. For elementary treatment, or for the purpose of establishing the laws of thermodynamics, the definitions $Pv = f(T)$ and $v = kT$ are the best. For the purpose of complete investigation of the various effects experienced with real gases the equations $Pv = f(T)$ and $\lambda = T(\partial P/\partial T)_T - P = 0$ are preferred. A perfect gas, defined as one which obeys the laws of Boyle and Joule is free from all logical uncertainty, and is applicable to all the experimental work involved in the determination of the ice-point. F. J. B.

898. *Validity Ranges of Gas Equations.* **I. W. Herz.** (Zeits. Elektrochem. 30. pp. 604–607, Dec., 1924.)—The formula of Nernst $p(v - v_1) = \mathrm{RT}\,(1 - p/p_k)$, where v and v_1 are the volumina in the gaseous and liquid states and p_k is the critical pressure, has only been tested with respect to fluoro-benzene and holds, according to van Laar, up to a temperature of about 0·8 of the critical T_k. If the formula were generally applicable $p(v - v_1)/\mathrm{T}(1 - p/p_k)$ should have the constant value $\mathrm{R} = 0{\cdot}08207$. Using the tables of Landolt-Börnstein, the author finds that this is approximately so for a large number of organic and inorganic substances up to about 0·8 or 0·9 T_k. The rule does not hold for acetic acid, where the constant is much too small up to about 560° ($\mathrm{T}_k = 594{\cdot}6°$), but would do so if the molecular weight of the acid were double the assumed. In other cases, for instance, those of the atmospheric gases, the assumption of association would not explain the discrepancies found. H. B.

899. *Effect of Molecular Attractions on the Total Pressure of a Gas Mixture.* **O. Maass** and **D. M. Morrison.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 49–55, 1924.)—Dalton's law applies only to a mixture of ideal gases, and is not strictly true in general. The authors investigated the gases helium, hydrogen, carbon dioxide, carbon monoxide, oxygen, methyl ether, and ammonia. The apparatus by which the pressure was measured had been described in a previous paper, and results are given for the change of pressure which takes place on mixing two gases, each occupying one litre at atmospheric pressure, to form exactly two litres. The increase is 0·1 mm. for hydrogen and helium, and the greatest observed increase was 4·1 mm. for helium and methyl ether. Hydrogen apparently fulfils the condition of the ideal gas, as the attraction of hydrogen for hydrogen is negligible. [See Abstract 2858 (1924).] G. E. A.

900. *The Thermic Slip in Gases.* **M. Czerny** and **G. Hettner.** (Zeits. f. Physik, 30. 4–5. pp. 258–267, 1924.)—The thermic slip, which is fundamental in radiometer phenomena, produced by a very simple arrangement and its amount measured in air, hydrogen, and helium. The amount is in accord with theory. A. D.

901. *The Joule-Thomson Effect for Helium.* **J. H. Perry.** (J. Phys. Chem. 28. pp. 1108–1112, Oct., 1924.)—The Keyes type of equation of state $\mathrm{P} = \mathrm{RT}/(\mathrm{V} - \delta) - \mathrm{A}/(\mathrm{V} + l)^2$ gives for helium $\mathrm{P} = 20{\cdot}53/(\mathrm{V} - 3{\cdot}17) - 3285(\mathrm{V} + 6{\cdot}85)^2$. Tables are given showing the observed values of H. K. Onnes, of Holborn, and Schultze, and of Holborn and Otto, together with the values calculated from the above equation; the agreement is good from 56·58° K. to 373·49° K. An expression is deduced from the Joule-Thomson coefficient, and the values of the coefficient calculated for the five isobars 1, 5, 25, 50 and 100 atmospheres. The inversion temperature at which the Joule-Thomson effect changes sign and $\mu = 0$ is slightly less than 100° K. at one atmosphere; the inversion temperature decreases as the pressure increases. H. N. A.

902. *Theoretical and Practical Study of Convection of Heat.* **G. H. Perrin.** (Rev. Gén. d'Él. 17. pp. 3–13, Jan. 3, 1925.)—From considerations of conduction and convection in a fluid the general equation of heat flow is established. By considering firstly bodies geometrically similar and then extending the calculation, the effect of different factors is obtained, and thus a coefficient of convection evaluated. This is applied to cases of natural and constrained convection, and again when the effects of viscosity or inertia may be neglected. These coefficients are calculated for H_2, CO_2, air, water, and transformer oil at 20° C. and 50° C., and thus indirectly a measure is obtained of the power of these substances to serve as an agent of cooling (*e.g.*, in electric filament lamps or transformers). The values obtained by others for convection from a plane vertical surface, a cylinder and a sphere are given. Finally, he considers the effect on convection of surrounding pressure and of gravitation. R. S. R.

903. *Property-Composition Curves of Binary Mixtures of Liquids.* **L. Frank.** (Zeits. phys. Chem. 114. pp. 257–274, Dec., 1924.)—The formulæ for the $(p\text{–}x)$ curves for the predetermination of the properties of binary mixtures given by van der Waals and by Duhem-Margules are very complicated. The formulæ of Dolezalek [Abstract 1450 (1921)] are simpler; but he presumes association or formation of additive compounds. By generally combining van der Waals' equation of state $(p + a_x/v^2)(v - b_x) = RT$ with Maxwell's principle of dimensions—$\dim [v] = \dim [b_x]$; $\dim [p] = \dim [a_x/b_x^2]$; $\dim [T] = \dim (a_x/b_x^2] \times \dim [b_x]$—as van der Waals and Kuenen had done for critical mixtures—the author, without making any assumptions, arrives at formulæ which he applies to the experimental data of various authorities concerning p, v, T, surface tension and viscosity. Some forty mixtures, comprising liquefied gases, are taken at different concentrations. The agreement between calculated and observed data is satisfactory in general, but unsatisfactory for mixtures with water and also for benzene-acetic acid and chloroform-ether. There is a difficulty about the correct values to be assigned to the b. H. B.

904. *The Vapour Pressure of Ice and Water below the Freezing-Point.* **E. W. Washburn.** (Monthly Weather Rev. 52. pp. 488–490, Oct., 1924.)—The method adopted for the computation of tables of vapour pressures included in the International Critical Tables is described. The experimental data are discussed and interpolation formulæ are deduced from thermodynamic principles. The equation employed for ice under its own vapour pressure is

$$\log_{10} p = -\frac{2445\cdot5646}{T} + 8\cdot2312 . \log_{10} T - 0\cdot01677006 . T + 1\cdot20514\cdot10^{-5} . T^2 - 6\cdot757169$$

Having obtained the values for ice, the values for supercooled water under its own pressure are obtained from the relation:

$$\log_{10}\frac{p_w}{p_i} = \frac{-1\cdot1489 . t}{(273\cdot1 + t)} - 1\cdot330 . 10^{-5} . t^2 + 9\cdot084 . 10^{-8} . t^3$$

Formulæ are included which give the corrections to be added if the vapour pressures of ice or supercooled water are required under atmospheric pressure. A. W. L.

SOUND.

905. *Wave-Length of Maximum Energy in the Sound Spectrum of an Explosion.* **A. Dufour.** (Comptes Rendus, 179. pp. 759–761, Oct. 20, 1924.)—Reference is made to a note on this subject by Villard [see Abstract 398 (1925)]. Records are reproduced showing the character and duration of the explosion have emanating from (*a*) 77 mm. gun, (*b*) 210 mm. gun, and (*c*) the explosion at La Courtine; the weights of explosive in these cases being 0·5 kg., 29 kg., and 10,000 kg. respectively. The approximate values of the periods of the principal waves are 0·06 sec., 0·18 sec., and 1 sec. respectively. It appears from such results that the period of the wave of maximum energy increases with the weight of explosive. Further experiments are necessary to determine the exact law of variation. A. B. W.

906. *Oppau and La Courtine Explosions.* **Rothé, Lacoste, Bois, (Miss) Dammann** and **(Miss) Hée.** (Comptes Rendus, 179. pp. 507–509, Sept. 8, 1924.)—Seismograms of the explosions are given. A comparison shows that the seismogramme have a general resemblance, especially if allowance is made for difference in the instruments concerned in the recording. [See Abstract 1333 (1923).] W. A. R.

907. *Propagation of Aerial Waves and the Observations of La Courtine.* **C. Maurian.** (Comptes Rendus, 179. pp. 1334–1337, Dec. 8, 1924.)—Discusses by the aid of maps isolated regions in France of normal or abnormal reception of sounds; the phenomena in question it is sought to explain by means of winds and various temperatures. E. H. B.

908. *Audibility of Explosive Waves at Great Distances.* **M. Collignon.** (Comptes Rendus, 179. pp. 1615–1617, Dec. 29, 1924.)—Further details of the audible regions from the experiments of La Courtine in May, 1924, and comparisons with effects under various wind conditions in 1917–1918. [See Abstract 2300 (1924) and preceding Abstract.] E. H. B.

909. *Some Types of Sensitive Flames.* **L. H. Jordan** and **R. K. McClung.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 197–201, 1924.)—In this paper are described high- and low-pressure flames, both forms designed to detect faint sounds. The high-pressure flames used gas at a minimum pressure of 2 in. of water. They were specially sensitive to hissing and metallic sounds and to those of high pitch even ultra-audible. In this group flames were produced from $\frac{1}{8}$ to $\frac{3}{8}$ in. in diameter and from 3 to 30 in. in length. For these flames a very perfect nozzle is needed and a very steady and controllable jet. The low-pressure flames were produced by enclosing the nozzle in a brass hemispherical chamber from which the gas emerged, passed up some distance, then encountered a horizontal sheet of gauze, *above* which it was ignited, the flame being surrounded by a gauze cylinder. Gas pressures from $\frac{1}{2}$ to $1\frac{1}{2}$ in. of water used with this type of burner gave flames very sensitive to sounds such as the lower tones of the human voice. E. H. B.

910. *The Theory of the Thermo-Microphone.* **A. v. Hippel.** (Ann. d. Physik, 75. 5. pp. 521–548, Oct., 1924.)—The question is considered whether a faithful conversion of sound into electrical waves is attainable by the use of heat as an intermediary. It is pointed out that there are three possible influences of acoustic disturbances upon an electrical conductor: firstly, the changes of temperature that take place at sound nodes; secondly, the changes in velocity of the air that take place between the sound nodes; and thirdly, this latter phenomenon in combination with convection currents. The first and third of these have a bearing on the problem of the thermo-microphone. Again, in passing from the acoustically excited heating effect to electric waves three main possibilities exist, according as the conductor is metallic or electrolytic and the receiver is placed in the primary microphone circuit or in the secondary circuit. Where the phenomena dealt with are capable of more rigorous treatment the results are worked out mathematically and expressed as formulæ. **J. Friese** and **E. Waetzmann.** (Ibid. 76. 1. pp. 39–40, Jan., 1925.) G. A. S.

[911. *Acoustic Wave Filters; An Extension of the Theory.* **G. W. Stewart.** (Phys. Rev. 25. pp. 90–98, Jan., 1925.)—In the simple form of acoustic wave-filter theory already published, the wave-length was assumed long in comparison with the length of a section of the conduit. Experimentally additional bands appeared at higher frequencies and these are now discussed. Advantage is taken of the recurrence at higher frequencies of the vanishing of the acoustic impedance of a section of the conduit, and approximate values of the components of this impedance are established for the neighbouring region of frequencies. Formulas for low-pass and single-band-pass filters, using these values, are found to give the experimental cut-offs of the additional bands with satisfactory accuracy. By appropriate design an additional band can be made practically to disappear. Tables showing agreement of experiment with theory are given. The theory is thus extended to higher frequencies, but not to those for which additional resonance frequencies of the branches occur. [See Abstract 630 (1925).] AUTHOR.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

912. *Galvano-Magnetic Experiment upon Iron.* **G. Polvani.** (N. Cimento, 1. pp. 359–368, Oct.–Nov.–Dec., 1924.)—As the result of the experiments described it is considered that the twisting of the line of the current may be due in part to the varying conductivity which the metal possesses in a parallel and transverse sense to the field, in part to the combination of the Wiedemann and Thomson effects. No attempt is made to distinguish between the parts played by these agencies, but simply to take count of a direct experiment to verify the ionic theory of metallic conductivity. A. E. G.

913. *Barlow's Wheel.* **A. Carrelli.** (N. Cimento, 1. pp. 369–385, Oct.–Nov.–Dec., 1924.)—The electronic theory both in its classical form as proposed by Riecke, Drude, Lorentz, and in its successive modifications has been shown incapable of furnishing a satisfactory interpretation of the various phenomena observed with metals and markedly the thermic and galvanomagnetic phenomena. The present experiments based on the Barlow wheel are intended to throw some light on the matter and to furnish precise indications upon the mechanism of the action of the force upon a conductor through which a current flows when immersed in a magnetic field. A. E. G.

914. *On the Theorem of Equivalence of a Double Layer and a Vortex Line.* **C. de Jans.** (J. de Physique et le Radium, 5. pp. 368–376, Dec., 1924.)—The author demonstrates a proposition which may be considered as the converse of the theorem of equivalence of a linear electric current and of a magnetic sheet, or, more generally, of a double layer and a vortex line. He shows that a certain system of general hypotheses completed by the postulate of the identity of the fields, leads in a unique manner to the laws of Coulomb and of Biot-Savart-Laplace. The same group of hypotheses, to which is added the postulate that the flux due to the sheet and received by any other surface only depends on the contours of the sheet and surface, leads also in a unique manner to Coulomb's law. The demonstrations are based on the vectorial calculus of Gibbs, from which the author derives two new transformation formulæ.
H. H. Ho.

915. *Absorption of Electromagnetic Waves by Ice.* **J. Granier.** (Comptes Rendus, 179. pp. 1313–1316, Dec. 8, 1924.)—The author has determined the respective values of the resistance and specific inductive capacity of ice at − 12°, for currents of frequency ranging from 4·3 to $6{\cdot}7 \times 10^6$ cycles per sec. The results indicate that the ice condenser employed could be schematically represented by two condensers in parallel, the one having a specific inductive capacity equal to 2·05 and the other equal to about 78, a resistance being placed in series with the latter.
J. S. G. T.

916. *The Variation of Residual Charge and the Ratio of Electrical Conductivity to Capacity due to Temperature.* **H. Saegusa.** (Inst. El.

Eng. of Japan, J. No. 432. pp. 651–678, July, 1924.)—Particulars are given of the variation with temperature of the residual charge and of the ratio of electrical conductivity to capacity in the case of crystalline dielectrics—quartz, mica, rock salt, selenite, microcline, scheelite, and barite—and some amorphous dielectrics—ambroid, paper, paraffin, ebonite, and glass—for the range of temperature 0°–320° C. The results indicate that the time in which the residual charge becomes saturated decreases with rise of temperature whilst the residual charge increases. The saturation value of the residual charge increases with temperature to a maximum and then decreases to a constant value. The ratio of conductivity to capacity increases slowly at first with temperature, then rapidly and finally tends to a saturation value. In general this ratio increases much more rapidly than the corresponding value of the saturation residual charge. The variation of residual charge with temperature is attributable principally to the variation of conductivity as the temperature-variation of capacity is relatively very small. Crystals of the monoclinic system in general are characterised by a high temperature at which the residual charge becomes a maximum and by a small residual charge. Amorphous dielectrics, in general, become appreciably conducting above 100° C. J. S. G. T.

917. *The Electric Current Considered as a Circulation of Equal Charges of Opposite Sign.* **F. Guéry.** (Comptes Rendus, 179. pp. 1036–1039, Nov. 17, 1924.)—Previous work by Lorentz, Gauss, Weber, and Maxwell is noticed. Maxwell has shown that only two hypotheses are valid for the respective values of the positive and negative charges which constitute the current: either the absolute values are in the inverse ratio of the squares of their velocities or they are equal. The latter is adopted in the present paper, and an expression for the reciprocal energy of two charges is derived when the motion is uniform and rectilinear which depends not only on the magnitude, distance apart, and relative speed of the charges but also on the nature of the trajectory. Following a discussion of this expression, a section considers the problem from the standpoint of the special theory of relativity. [See Abstract 399 (1925).] H. H. Ho.

918. *Dispersion of Hertzian Waves in Solids in the Neighbourhood of the Point of Fusion.* **J. Errera.** (J. de Physique et le Radium, 5. pp. 304–311, Oct., 1924.)—The variation with the frequency (λ varying from 500 m. to 1000 km.) of the specific inductive capacity of solid in the neighbourhood of the point of fusion is investigated. The method used is a modification of the Nernst capacity method. Control experiments gave constant specific inductive capacity for the standard liquids employed. In this first series acetic acid, nitrobenzene, ethylene bromide, and some other organic compounds are examined. The curves of dispersion depend on the temperature. At all temperatures the specific inductive capacity increases with the wave-length. This increase is very pronounced near the point of fusion but becomes very small at low temperatures. Solidification involves a sharp variation in specific inductive capacity. At high frequencies solidification diminishes the capacity, at low frequencies, on the contrary, it seems that on solidifying the capacity of the bodies increase. The most natural interpretation is to admit that the specific inductive capacity of a substance may be derived from two effects: on the one hand, the polarisation by displacement or orientation of heavy charged particles; on the other hand, the movement of electrons at the interior of each particle which involves the polarisation of the constituent elements. These effects have a different relative importance according to the frequency and the temperature. The solid state, from an electric point of view, is characterised by a small constant specific inductive capacity, commencing at a different temperature according to the frequency. A. E. G.

919. *Quantitative Theory of the Influence Electrostatic Generator.* **A. W. Simon.** (Phys. Rev. 24. pp. 690–696, Dec., 1924.)—A rigorous mathematical theory of the static machine is given and applied in detail to a simple four-element machine of a type exemplified by the Kelvin replenisher. It is shown that the potentials of each of the inductors after n cycles satisfies an equation of the form $V_n = C_1 r_1^n + C_2 r_2^n$, where r_1 and r_2 are constants which depend only on the coefficients of capacity and the coefficients of induction of the elements in two configurations, and C_1 and C_2 are constants which depend both on the initial values of the potentials of the inductors and the coefficients of capacity and of induction of the elements in the two determining configurations. The values of the various constants for a non-symmetrical machine, and also for a symmetrical machine are given in tables. It is shown that theoretically the potential produced by an ordinary static machine will increase without limit, approach a constant value, or decrease to zero, depending on the phase at which the brushes are grounded. AUTHOR.

920. *Electrostriction in Liquids which are only Slightly Birefracting.* **M. Pauthenier.** (J. de Physique et le Radium, 5. pp. 312–320, Oct., 1924.)—Electrostriction manifests itself in fluid dielectrics by an increase of density and in consequence of the index of refraction in the presence of an electric field by an accumulation of fluid in regions of intense field. This effect superposes itself in general on that of electric birefraction. The object of the present work is to put in evidence the phenomenon of electrostriction in such liquids as benzene and carbon tetrachloride in which it exists only in consequence of very slight birefraction. An interferential method analogous to that employed by the author in the study of birefraction is used to measure the difference of index between the interior liquid and the exterior liquid in a charged condenser. This charge is established during a time of the order of 10 thousands of a second, sufficient for setting up electrostriction but too short for an appreciable Joule effect to arise. It is found that an increase of the index of electrostriction is produced effectively in liquids which do not exhibit birefraction, in general quantitative accord with a theoretical formula obtained by assuming the Lorentz relation between the index and the density. Nevertheless, the results obtained with carbon tetrachloride exceed the values calculated. The theory appears to be incomplete. A. E. G.

DISCHARGE AND OSCILLATIONS.

921. *Minimal Length Arc Characteristics.* **H. E. Ives.** (Frank. Inst., J. 198. pp. 437–473, Oct., 1924.)—This paper which gives a general survey of the subject deals with it under the following heads: arc characteristics; the break arc; determination of voltage-current characteristics from the break arc; methods and apparatus; distinction between the break arc and the break spark; isolation of the break arc by means of a shunted valve; experimental determination of arc characteristics; anode and kathode of different materials; phenomena in various gases; the complete voltage-current characteristics of the discharge between separating contacts. Evidence is presented that the discharge occurring between separating electrodes is, for large currents, an arc; for small currents, an atmospheric spark. A method for isolating the arc discharge for study is described. Arc characteristics for arcs of extremely short length are experimentally obtained, and the relationship of these minimal length arc characteristics to finite length arc characteristics is discussed. The minimal length characteristics are used to develop an expression for the voltage-current-time relations in break arcs. The whole is fully illustrated with graphs showing the relationships dealt with. A. E. G.

922. *The Striking and Breaking Potentials for Electron Discharges in Hydrogen.* **O. W. Richardson** and **T. Tanaka.** (Roy. Soc., Proc. 106. pp. 640–662, Dec. 1, 1924.)—It is well known that in thermionic tubes containing gas at a low pressure discontinuous increments of the current occur at certain critical voltages. They are usually accompanied by the appearance or disappearance of luminosity or by change of type of some luminosity already present. The phenomena are irreversible, the "striking" potential at which a given type of discharge sets in being usually higher than the "breaking" potential at which the same type of discharge reverts. These effects are in general very complicated and depend on the geometrical structure and arrangement of the electrodes, the nature and pressure of the gas, and the temperature of the emitting kathode. They also seem to depend on the previous history of the tube and generally to behave in a capricious manner. The experiments here described are confined to hydrogen as the gas and show that under the conditions given the phenomena are quite definite and reproducible and not too complicated. Three types of discharge are described. The fact that the limiting value of the breaking potential is identical with the ionisation potential shows that a necessary condition for the maintenance of the first-type discharge is the production of a supply of positive ions, and that in the limiting case this supply arises at the surface of the anode. The fact that the striking potential is higher than the breaking potential suggests that the distribution of electric field prior to the striking of the discharge is less efficient for the production of positive ions than that which establishes itself under the same electrode potentials when the discharge has developed. Both the agreement of the limiting value with the ionising potential and the shapes of the curves show that the breaking potential is a more fundamental quantity than the striking potential. For any given pressure and electrode distance both striking and breaking potentials fall asymptotically to limiting values as the electron emitting power of the kathode is increased. For some pressures and electrode distances it is observed that although the second-type discharge struck at a much higher potential than the first-type, both broke at the same potentials for a considerable range of kathode temperatures. At any given electrode distance both striking and breaking potentials have a minimum value at a certain pressure, and both increase from that value as the pressure is either raised or lowered. The minimum breaking potential, although practically constant for electrode distances below 7 mm., increases steadily with increasing distance for larger distances. These results do not throw any light on the question as to the nature of the process which occurs at the ionising potential. Any process which results in a considerable yield of free positive ions will satisfy the requirements of these experiments. In one particular the present observations are in disagreement with those of Horton and Davies, at least if the blue sheath which they describe as terminating the pink glow is the same as the blue layer which is now found to cover the bell-shaped mass of pink luminosity present in front of the anode in the first-type discharge. By comparing the intensities of the lines of the secondary spectra in the first, second, and third type discharges with those in a Geissler tube, it is found possible to pick out groups of lines which are selectively either weakened or strengthened. By considering the other physical properties of these selectively affected lines, it is possible to arrange a considerable number of them in series. This subject is to be dealt with in subsequent papers. [See Abstract 848 (1925).] A. E. G.

923. *Sparks Lag and Shape.* **P. O. Pedersen.** (Ann. d. Physik, 75. 8. pp. 827–847, Dec., 1924.)—This is the second part of some researches on the electric spark, the first part of which have already appeared [see Abstract 2485 (1923)]. In the present paper the following aspects of the subject are dealt with: spark lag in homogeneous fields; the dependence of the minimum lag on the field distribution along the spark path; the spark path in homogeneous and unhomogeneous fields at higher pressures; the spark path at low pressures; the effect of the presence of metallic salts on the electrode surfaces. There are a series of photographs showing the appearances of sparks in atmospheric air between clean electrodes, and in various other gases such as H_2, CO_2, O_2, N_2; photographs showing the formation of sparks with slowly increasing tension at a pressure of 750 mm. Hg with clean electrode; also photographs in air, one or both of the electrodes having a think oil layer. Spark photographs in air at low pressures are also shown. A. E. G.

924. *Space Charge Effects in Valves with Oxide-Coated Kathodes.* **A. Katsch.** (Zeits. techn. Physik, 5. 11. pp. 505–511, 1924.)—A systematic investigation was made of the variations in the characteristics of valves with (i) ordinary tungsten filaments, (ii) thoriated tungsten filaments, and (iii) filaments coated with oxides of the alkaline earths. The results obtained are shown in a series of diagrams. Under otherwise similar conditions the characteristic of a valve with a filament coated with barium oxide is further to the right than the corresponding curve for a valve with a pure tungsten filament. The characteristic for a certain valve with oxide-coated filament and an anode potential of about 80 volts, is practically coincident with that for a similar valve with tungsten filament and an anode potential of 50 volts. The results for calcium and strontium oxides will be given in a later paper together with those for thoriated tungsten. A. W.

925. *The Kathode Fall of Potential in a High-Voltage Discharge.* **G. P. Thomson.** (Roy. Soc. Edinburgh, Proc. 44. 2. pp. 129–139, 1923–1924.)—Measurements of the kathode fall of potential for total discharge potentials of 15,000–45,000 volts have been made by determining the electric force required to give the positive rays a standard deflection. Since this deflection for a given force is inversely proportional to the energy of the rays, a measure of the latter is thus obtained. The rays measured were those with the maximum energy. It was found that the kathode fall was less than the total discharge potential and varied with it in a linear manner for voltages above about 15,000 volts. The relation is independent of the pressure within the limits examined and of the metal of the kathode except that Al when coated with a film of impurity showed anomalous results until the film disappeared. It is also the same for air as for H_2, at least when the air contains a little H_2. Further, the relation does not depend appreciably on the position of the anode. A theory of the dark space at the pressures considered, under certain assumptions, is given which accounts for some of the above results. R. S. R.

926. *Application of Positive Ray Analysis to Ionisation Problems.* **H. D. Smyth.** (Frank. Inst., J. 198. pp. 795–811, Dec., 1924.)—Almost simultaneously with the appearance of Bohr's first paper on atomic structure, Franck and Hertz, developing an idea of Lenard's inaugurated a series of experiments which were to prove of great importance to theories of atomic constitution. They undertook to study the effect of collisions between slow electrons and gaseous molecules as a function of the speed of the electrons and the nature of the gas. Horton and Davies in this country, McLennan in Canada, and Compton, Foote, and Mohler in U.S.A., took up the work and soon its direct relation to Bohr's ideas became apparent. The present paper deals largely with the limitations of these experimental methods. When the results presented are considered, one important principle emerges. In all three diatomic gases studied, the first ionisation potential corresponds to ionisation without dissociation. Moreover, if an impacting electron ever causes dissociation simultaneously with ionisation, it is first able to do so at such a high voltage that the transition cannot be represented by such a thermochemical equation as $X_2 + D + Jx + \rightarrow X^+ + X$ where D is the heat of dissociation and Jx the ionising potential of the atom. It would be possible to explain the critical potential for N^+ by an equation of the form $N_2 + D + 2J_N + \rightarrow N^+ + N^+$, which would be satisfied for $D = 6$ volts and $J = 11$ volts, reasonable values. But in oxygen and hydrogen where the values of J and D are known approximately there is no agreement whatever. It is, therefore, necessary to conclude that, at least for homopolar compounds, it is not possible to apply thermochemical equations to these transitions caused by electron impact. This invalidates, of course, any deduction of heats of dissociation from ionisation potential experiments. The evidence on the applicability of thermochemical equations to similar phenomena in heteropolar compounds is conflicting. It is hoped that this problem can be settled by studying such substances with the method here described. The secondary effects obtained in hydrogen suggest a series of experiments on the dissociation and association of ions by molecular impact. Such studies may perhaps throw light on the questions of the mechanism of ionisation and of molecular structure. A. E. G.

927. *An Explanation of the Surface Effect Occurring in the Propagation of Electric Waves in Perfectly Insulated Iron.* **A. Léauté.** (Comptes Rendus, 179. pp. 597–600, Sept. 29, 1924.)—A mathematical discussion of the subject showing that the surface effect gives a different damping factor for all the various harmonics, and that the same damping would only occur for all harmonics if the surface or skin effect was zero. If the surface effect is very small, the damping of all the factors is represented approximately by the effect itself. The increment of damping is very marked for the higher harmonics. The paper confirms the protective power which the lines in iron offer against such waves. S. G. B.

928. *Electron Emission of Metals.* **A. Becker.** (Ann. d. Physik, 75. 8. pp. 781–800, Dec., 1924.)—A general theoretical discussion of the question in which the nature of electron emission from metals owing to the action of α-rays, etc., is dealt with. The Richardson conception of the mechanism of the glow-electron emission is discussed as is also the question of δ-radiation. [See also Abstract 3046 (1924).] A. E. G.

929. *Formulas for the Amplification Constant for Three-Element Tubes in which the Diameter of Grid Wires is Large Compared to the Spacing.* **F. B. Vogdes** and **F. R. Elder.** (Phys. Rev. 24. pp. 683–689, Dec., 1924.)—Previous formulas which have been developed for the amplification constant in plane parallel three-element tubes, do not take full account of the diameter of the grid wire. In this paper after making a conformal transformation, from the plane w to the plane z, where $w = \log z$ and making an approximation which is sufficiently accurate for all diameters of grid wire up to one-third the spacing, formulas are derived which give results in good agreement with the values determined from two series of actual tubes for which the older formulas are greatly in error or fail entirely. AUTHORS.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

930. *A New Experiment upon the Hall Effect.* **G. Polvani.** (N. Cimento, 1. pp. 283–310, Oct.–Nov.–Dec., 1924.)—This paper is divided into two sections. In the first, theoretical and experimental considerations are dealt with, and a detailed description, with diagram, of the new experimental arrangements upon the Hall effect is given. In the second part the ionic theory of the new experiment on the Hall effect and the influence upon it of a longitudinal magnetic field is considered mathematically. A. E. G.

931. *Conductivity and Catalytic Action of the Three Strong Halogen Hydracids in Methyl and Ethyl Alcoholic Solutions.* **H. Goldschmidt** and **P. Dahll.** (Zeits. Phys. Chem. 114. pp. 1–22, Dec. 13, 1924.)—Results are given of measurements of the electrical conductivities of solutions of sodium chloride, bromide, and iodide and of hydrogen chloride, bromide, and iodide in methyl and ethyl alcohols at 25°. The courses followed by the $\lambda : V$-curves are different with either alcohol, sodium chloride showing the steepest, and hydrogen iodide the flattest, curve. Kohlrausch's law concerning the independent migration of the ions is obeyed by both the methyl, and the ethyl alcoholic solutions. The values of λ_∞ for the three halogen hydrides are similarly influenced by addition of water. The formation of esters in methyl or ethyl alcoholic solutions is catalysed to equal degrees by equally concentrated solutions of the three acids. Even in solutions of infinite dilution the three halogen hydracids are not completely, although almost so, dissociated in methyl or ethyl alcohol. T. H. P.

932. *Photovoltaicity of Halides of Silver and the Mechanism of Formation of the Latent Image.* **R. Audubert.** (Comptes Rendus, 179. pp. 1046–1049, Nov. 17, 1924.)—The formation of the latent image has been the object of numerous theories; some are of the physical order and do not give any representation of the phenomenon; others are of the photochemical order and are more precise but are not able to be verified, for it is impossible to isolate a sufficient quantity of the substance formed as it exists only as traces even in the more exposed plates. The halides of silver are very photoelectric; they are also very probably so in the presence of electrolytes; *e.g.* it is without doubt by loss of electrons that an electrode of silver chloride plays the *rôle* of anode under the influence of visible radiations. The relative experimental results on the photovoltaicity of the silver salts lead to a simple explanation of the mechanism of the formation of the latent image and interprets some properties of the photographic plate. This view, however, does not exclude the possibility of more complex photochemical processes, nor the sensitising action of the gelatine. [See **Abstract 206 (1925).**] A. E. G.

933. *Photoelectric Cells—The Case High-Vacuum Type.* **C. F. Elwell.** (Electrician, 93. pp. 520–522, Nov. 7, 1924.)—A photoelectric cell usually consists of a glass of quartz bulb containing two electrodes. One electrode is the photoactive material, and is the surface to be illuminated; the other usually consists of a loop of wire and serves as a collector of photoelectrons emitted by the photoactive material. The photoelectrons are driven across the cell as the result of an applied potential and their number is indicated by any suitable current-measuring instrument. In a cell having a very high vacuum the entire current is carried across the cell by the photoelectrons. In a correctly designed cell the photoelectric current is directly proportional to the light intensity falling upon the cell. In the present paper the types, in particular the thalofide cell, developed by Case are discussed. Thalofide material is composed of thallium, oxygen, and sulphur, which is fused on a three-quarter inch quartz disc. The cells are constant over a period of many months to within 2 or 3 % variation about a mean line, and are not injured by exposure to sunlight. The photoelectric current does not vary more than 2 % for a temperature range from 0 to 100 deg. The photoelectric current increases with the voltage up to about 140 volts. Higher voltages make very little difference in the photoelectric current. If a cell is run on 170 volts a small variation in voltage will make no appreciable effect in the photoelectric current. The photoelectric current is directly proportional to the light intensity to which the cell is active when a voltage above the saturation-point is used. This is one of the advantages of the high vacuum cell, as it is not necessary to use a protective resistance as there is no gas to break down. The cells can be used with 220-volt direct current where such a source is available. The various applications of these cells are briefly discussed. A. E. G.

934. *The Dielectric Properties of Mica. An Investigation carried out for the British Electrical and Allied Industries Research Association.* **D. W. Dye and L. Hartshorn.** (Phys. Soc., Proc. 37. pp. 42–55; Disc., 55–57, Dec., 1924.)—Two methods used for determining the dielectric constant of thin sheets of mica are described and the errors discussed. The results of measurements on over 170 sheets of mica are given. The samples tested included best clear mica, ruby, green and brown in colour, stained and spotted samples, and also samples with gaseous inclusions. There were also samples of amber mica and silver amber mica. The results show that practically all samples of muscovite (potassium mica) have the same dielectric constant, the most probable value being 7·0. The presence of inclusions has no great effect on this value. The samples of phlogopite (magnesium mica)—*i.e.*, the amber micas—have rather lower dielectric constants, about 6·0 for normal amber mica, and 5·0 for the silver amber variety. Values of power factor are given for many of the samples. For the clear micas (muscovite) it may be as low as 0·0003, and possibly less. The effect of inclusions is to increase it considerably. The power factor of the amber micas is greater than that of the muscovite variety—about 0·02 for the clear amber and 0·05 for the silver amber variety. The samples were all about 8 cm. square and 0·1 mm. thick, and the measurements were all made on the Carey Foster bridge at a frequency of 800 cycles per second. AUTHORS.

935. *Dielectric Constants and Chemical Constitution with Organic Liquids.* **E. H. L. Meyer.** (Ann. d. Physik, 75. 8. pp. 801–818, Dec., 1924.)—A great part of this paper has been already published and abstracted [see Abstract 2327 (1924)]. In addition, the question of the existence of hybrid ions is discussed in the light of the author's representation of polar carbon atoms, and it is shown that Blüh's measurements [see Abstract 2587 (1924)] can furnish no definite proof of the presence of such ions. Fresh measurements reveal systematic deviations of both Debye's and Boguslawski's formulæ from rectilinearity, no better agreement being attained if, in accordance with Wiener's suggestion, the expression $(\epsilon - 1)/(\epsilon + 2)$ is replaced by $(\epsilon - 1)/(\epsilon + u)$. If the notion of a dipole is considered in relation to Sutherland's views, carbon atoms exhibit dipolar character in only slight degree; whether this depends on the external electric field is as yet uncertain. T. H. P.

936. *Dielectric Viscosity.* **J. Granier.** (J. de Physique et le Radium, 5. pp. 51–58, Feb., 1924.)—The paper is partly practical and partly theoretical. In the practical part there are described experiments on the losses of energy in condensers by leakage and on "cycles of viscosity" of condensers submitted to an alternating tension. The "cycle of viscosity" is the curve obtained by plotting charge stored at any instant by condenser against corresponding applied tension. Owing to the partly residual nature of the charges these are not in the same phase, and the "cycle of viscosity" for a sinusoidal current is an ellipse. The experiments, which ranged over frequencies from $1·5 \times 10^{-3}$ sec.$^{-1}$ to $6·5 \times 10^{7}$ sec.$^{-1}$, illustrate the dependence of the dimensions of the "cycle of viscosity," and thus of the energy absorbed per period, on the frequency and on humidity, among other things. From the theoretical point of view the results of importance are (*a*) that for very short wave-lengths, glycerine and some analogous substances show a sharply defined band of absorption characteristic of the constitution of the molecule. (*b*) In all other cases, the coefficient of absorption shows neither maximum nor minimum and varies in a sense inversely as the frequency, while it is not characteristic of the nature of the dielectric, but is the more important the more impurities there are present. It appears then that theories of the nature of dielectric viscosity must allow

for two causes of absorption, that corresponding to (*a*) having its seat within the molecule, while in the other case it is extra-molecular and probably of electrolytic origin, arising from traces of electrolytic matter occluded or dissolved in the pure dielectric. M. A. G.

937. *Some Electrical Properties of Liquid Sulphur.* **D. H. Black.** (Cambridge Phil. Soc., Proc. 22. pp. 393–399, Sept., 1924.)—The electrical conductivity of liquid sulphur varies with the temperature in a manner similarly to the viscosity, and the conduction is electrolytic in character. A definite e.m.f. of polarisation is observed. T. H. P.

938. *Measurements on Krarup Conductors.* **U. Meyer.** (Zeits. techn. Physik, 5. 12. pp. 548–551, 1924. Paper read before the Deut. Naturforscher u. Ärzte, Innsbruck, 1924.)—Formulæ are derived for the dependence of the self-induction and resistance of Krarup conductors on the frequency and current strength. Experimental results are given which confirm the formulæ. A. W.

939. *Technical Application of the "Glow" Relay.* **H. Geffcken** and **H. Richter.** (Zeits. techn. Physik, 5. 11. pp. 511–514, 1924.)—After discussing the operation of the "glow" lamp [neon lamp] as a generator and the possibility of using it for measurements, a description is given of a new measuring apparatus, termed a "glow" bridge. With this it is possible to measure very quickly capacities from 10 to 10^7 cm. and resistances from 10^3 to 10^8 ohms, within about 1 %. Substitution methods are employed, and comparison of the resistance or capacity under test with the standard is effected by adjusting the standard so as to obtain the same note in the telephones. [See Abstract 610 (1920).] A. W.

940. *The Measurement of Decomposition Potentials.* **A. L. Ferguson and G. van Zyl.** (Am. Electrochem. Soc., Trans. 45. pp. 311–326, 1924.)—In this investigation an apparatus is developed, by which a direct comparison is made between all the values obtained by the commutator and direct methods for measuring decomposition potential and overvoltages. Evidence is given which should help materially to settle the controversy which has so long existed concerning the relative merits of these two methods. All measurements made by the commutator method are averages, and depend to a large extent upon the operation and mechanical construction of the commutator. AUTHORS.

ALTERNATING CURRENTS AND MAGNETISM.

941. *Theory of Determination of Ultra-Radio Frequencies by Standing Waves on Wires.* **A. Hund.** (Bureau of Standards, Sci. Papers, No. 491. pp. 487–540, 1924.)—In the parallel-wire system employed by the Bureau of Standards for frequency standardisation a valve generator is used for excitation, and a current-indicating instrument of low resistance is used as a bridge across the wires [see Abstract 309 B (1925)]. The present paper gives a complete mathematical treatment of the method, which is based on resonance conditions. The settings are therefore sharp, and it is possible to approach the theoretical accuracy in actual operation. The frequency f in kilocycles per second is calculated from a length l measured along the wires by means of the equation $f = v_0(1 - \Delta)/2l$, where v_0 is the velocity of light and l is the distance in metres between two consecutive maximum settings. The correction factor Δ is always small; a formula enables Δ to be calculated from the dimensions of the system. It is found best to keep the wires as short as possible, and just long enough to enable two maximum settings to be made. By connecting a small condenser across the input terminals, both maximum settings can be moved closer to the input end without changing the distance between them. The thermoelectric instrument used as detector, which is shunted by a wire of low resistance, does not affect the settings appreciably. A. W.

942. *Formulæ, Tables, and Curves for Computing the Mutual Inductance of Two Coaxial Circles.* **H. L. Curtis** and **C. Matilda Sparks.** (Bureau of Standards, Sci. Papers, No. 492. pp. 541–576, 1924.)—An exact formula for the mutual inductance of coaxial circles was derived by Maxwell in terms of elliptic integrals, but this does not readily lend itself to computation either when the coils are close together or far apart. For the latter purpose a large number of series formulæ have been developed, and the present paper deals with a simplified method for expressing the mutual inductance of coaxial circles either in terms of the radii of the circles and the distance between them, or in terms of a parameter which is a function of these dimensions. Tables have been prepared to aid in the computation by each type, and charts are included from which an approximate value of the mutual inductance can be read directly. A number of examples are given to show the methods of computation by the different formulæ, tables, and charts. The tables can also be used for the inverse problem of finding two circles which will give a desired inductance. Nagaoka's formula is recommended for certain ranges. H. H. Ho.

943. *A Study of Coils Wound on Rectangular Frames, with Special Reference to the Calculation of Inductances.* **Y. Niwa.** (Electrot. Laborat. Tokyo, Japan, Researches, No. 141. [133 pp.] April, 1924. In English.)—The recent great increase in the use of coils wound on rectangular frames in electrical engineering has stimulated research along this line, especially in the calculation of inductances. The present thesis includes not only the writer's former papers relating to this subject, but also many newly obtained results. As the writer's former papers touched mainly the magnetic field of the single layer square solenoid and the calculation of inductance of such coils, the writer has extended the formulæ to coils wound on rectangular frames. He also has obtained the formulæ for the mutual inductances of two square solenoids. The errors in the calculation of self and mutual inductances by substituting for the square or rectangular solenoids circular or square ones have been examined. As the mathematical formulæ obtained are based on the assumption of the current sheet distribution, the range of the applicability of these formulæ to the actual coils in engineering accuracy has been studied besides the method of correction to take into account the concentration of current in the wire. Formulæ for the calculation of the self-inductance of square coils with rectangular winding section have been derived with proper approximation. Also some applications in which self or mutual inductances of coils can be obtained by combining the fundamental formulæ of self and mutual inductances have been explained. As the present thesis has for its object not only the derivation of formulæ, but also the furnishing of the means of simplifying the calculation, numerous tables and curves have been prepared for the purpose of facilitating the actual calculation. AUTHOR.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

944. *Comparative Absorption Rates for Various Gases.* **W. G. Whitman** and **D. S. Davis.** (Indust. and Engin. Chem. 16. pp. 1233–1237, Dec., 1924.)—The rate of absorption of various gases through a free surface of liquid when the liquid is stirred, was measured. An 8-litre absorption chamber contained the gas and liquid, a stirrer, and a cooling coil. The absorption was determined by analysis of the solution in 4 litres of water when a steady stream of gas of constant composition was passed over the liquid. A sample of 4 grams was taken for hydrochloric acid and sulphur dioxide, for oxygen 250 c.c. were employed. The concentrations of the various solutions were determined by standard volumetric methods. The escape of sulphur dioxide from solution was determined in a similar manner, except that pure air was passed over the concentrated sulphur dioxide solution. The results show that the comparative absorption rates for the four gases, hydrochloric acid, ammonia, sulphur dioxide, and oxygen, can be adequately explained by the two-film theory. On the assumption that oxygen absorption is controlled by liquid film diffusion and that ammonia absorption in hydrochloric acid solution is controlled by gas film diffusion the absorption rates for sulphur dioxide, ammonia, and hydrochloric acid can be predicted with an accuracy of about 15 %. F. J. B.

945. *Absorption of Hydrogen Sulphide.* **F. W. Sperr, Jr.** (Indust. and Engin. Chem. 16. pp. 1237–1239, Dec., 1924.)—The absorption of hydrogen sulphide is of great importance in the artificial gas industry, and very high degree of absorption efficiency being required. Coal gas or water gas containing 100 to 800 or more grains per 100 cubic ft., must leave the purifiers so that a lead acetate paper is not stained after 1 minute's exposure. As an alternative to the usual dry absorbent employed, *viz.* hydrated oxide or iron, a solution of sodium carbonate containing 1 to 3 % was used in a tower divided into two sections, each filled with suitable packing. The upper section is known as the absorber, and the lower section as the actifier. The gas passes through the absorber, where it is washed with sodium carbonate solution. The solution flows down through the actifier, through which air is blown. The air removes the hydrogen sulphide, and the solution which is thus regenerated is pumped back to the absorber. The process operated to remove 85 to 90 % of the hydrogen sulphide, the remainder being taken out by oxide purifiers. The process increases the capacity of the oxide purifiers and renders it unnecessary to renew the oxide except after intervals of many months. F. J. B.

946. *Conditions of Maximum Solubility: Example of Gypsum.* **A. Colson.** (Comptes Rendus, 179. pp. 1041–1043, Nov. 17, 1924.)—Calorimetric experiments designed in consideration of a theoretical study of van't Hoff's results and the Clapeyron equation are described, and it is found by two methods that the precipitation of 1 gm. $CaSO_4$ (anhyd.) from supersaturated solution is associated with the disengagement of 8·8 cals. The concordance of results thus shows that the heat of solution at normal saturation has actually a positive value. Advantage is taken of Marignac's observation that gypsum dried at 140° C. yields supersaturated solutions which commence to precipitate to equilibrium at the end of about 15 mins. A. B. C. L.

947. *The Existence of Constant Solubility and the Displacement of the Maximum of Solubility.* **A. Colson.** (Comptes Rendus, 179. pp. 1399–1401, Dec. 15, 1924.)—Further experiments are carried out on the solubility and heat of solution of $CaSO_4$ [see Abstract 1177 (1916) and preceding Abstract)] the effects of the introduction of HNO_3 (up to 1·2 %) and of H_2SO_4 (up to 1 %) at 15° C. and at ebullition being noted and discussed theoretically. A. B. C. L.

948. *Critical Solution Temperature of Ternary Mixtures.* **A. Boutaric and G. Corbet.** (Comptes Rendus, 179. pp. 1319–1322, Dec. 8, 1924.)—Study of the miscibility of water with binary mixtures of phenol, aniline, salicylic acid, and benzoic acid shows that the critical solution temperature is a linear function of the composition only when the components of the binary mixture are of allied chemical character. Results are given also of determinations of the critical solution temperature of phenol with aqueous solutions of various alcohols. T. H. P.

949. *Piezo-Chemical Studies. XXVI. Influence of Pressure on Solubility. The System Naphthalin-Tetrachloroethane.* **E. Cohen, W. A. T. de Meester and A. L. T. Moesveld.** (Zeits. phys. Chem. 114. pp. 321–333, Dec. 24, 1924.)—The influence of pressure on solubility has been shown to be small compared with that of temperature, yet it is in some cases considerable. Theoretical researches lead to the conclusion that marked effects are to be expected only when solubility is diminished by pressure. As this diminution becomes less with increasing pressure, the question arises whether the solubility passes through a minimum or, with increasing pressure, approximates asymptotically to a definite value. An examination of the solubility of the system naphthalin-tetrachloroethane at 30°·00 C. and pressures from 0 to 1000 atmospheres revealed no minimum in the curve of solubility. [See Abstract 3079 (1924).] E. F.

950. *The Stokes-Einstein Law for Diffusion in Solution.* **C. C. Miller.** (Roy. Soc., Proc. 106. pp. 724–749, Dec. 1, 1924.)—Experiments are described with full details for diffusion in the case of dilute solutions of iodine at 8° to 20° C. to test the applicability of the Stokes-Einstein equation. The rate of diffusion D was measured in numerous organic solvents, and in various solutions of alkali bromides and iodides, as also the viscosity coefficients, Z, of the solvents. With respect to organic solvents, the observed inconstancy of the product DZ indicated the inapplicability of the Stokes-Einstein equation to the diffusion of ordinary dissolved molecules of the size of the iodine molecule. The variability of DZ does not appear to be connected in any simple way with the following properties of the solvents—mol. weight, mol. volume, density, viscosity, or dielectric constant. There was no obvious relation between DZ and the colour of the iodine solutions. For 15 organic and 24 aqueous solvents, the relative values of DZ were found to lie within the limiting values derived on the one hand from the Stokes-Einstein equation for large diffusing molecules, and on the other from the expression given by Sutherland for small diffusing molecules. With regard to salt solutions as solvents, DZ was found to be fairly constant for various bromide solutions. For iodide solutions the product increased appreciably, and almost linearly, as the concentration of the dissolved salt increased. The temp. coeff. of diffusion increased rather irregularly as the diffusion constant decreased. On the average, DZ scarcely increased with rising temp. to the extent required by the Stokes-Einstein equation. The diffusion process appears to be very complicated, partly owing to the non-fulfilment of Stokes' law by the diffusing mols., and partly to complications due to downward diffusion of the solvent or to upward and downward displacement of its constituents if the diffusion medium is a solution of another substance. H. H. Ho.

951. *Röntgen-Spectrographical Researches on the Nature of the Swelling of Substances Giving a Fibre-Diagram.* **J. R. Katz.** (K. Akad. Amsterdam, Proc. 27. 7–8. pp. 505–519, 1924.)—In the case of crystalline swelling bodies, Röntgen-spectrography is applied to ascertain whether water is received intermicellarly or as a solid solution intermolecularly. In the former case, the crystal lattice will not change, and, in the latter case, the dimensions of the lattice must become larger. The Röntgenograms given indicate that fibres are built up of many small elements, probably small crystals, all lying with one direction parallel to the fibre axis. As the interference spots in a fibre diagram lie on a set of hyperbolæ on the axis perpendicular to the fibre axis, the investigation is simplified to the measurement of the distance between symmetrical interference spots on the equator in moist and dry condition. If the water enters the lattice, the distance between each pair of these lines will become smaller. If no change of these distances takes place, the imbibition of liquid must occur intermicellarly provided that the substance which gives the Röntgen spectrum is also that which swells. The substances investigated are celluloses and hydrate-celluloses in the form of ramie fibres, before and after mercerisation by different methods, manilla hemp, artificial silk from viscose and from cuprammonium oxide. It is found that no difference in the dimensions of the Röntgenograms of swollen and dry celluloses can be shown with certainty indicating that the imbibition in all the cases examined is intermicellar. This conclusion is also supported by the change on prolonged swelling in strong sodium hydroxide. In these cases the crystalloids have lost their parallelism through receding from each other by the swelling, and the fibre diagram almost becomes a Debye-Scherrer diagram. [Abstract 696 (1925).] J. N. P.

952. *Corrosion Resistance of Steel Electroplated with Zinc and with Zinc-Mercury Alloys.* **C. J. Wernlund.** (Am. Electrochem. Soc., Trans. 45. pp. 273–279; Disc., 279–280, 1924.)—Corrosion studies of three types of zinc electrodeposits were made. Deposits containing 2 % of mercury were more resistant than deposits of pure zinc obtained from either sulphate or standard cyanide baths. AUTHOR.

953. *A Note on Propeller Brass.* **A. Logan.** (Inst. of Metals, J. 32. pp. 477–480, 1924. Abstract.)

954. *Fatigue Constancy at High Frequencies.* **W. Hort.** (Zeits. techn. Physik, 5. 10. pp. 433–436, 1924.)—Describes tests made with special apparatus (including the use of triode values) of the constancy of fatigue phenomena exhibited by turbine blades which are set in vibration and their dampings observed and recorded. E. H. B.

955. *A Further Study of the Dezincification of Brass.* **C. F. Nixon.** (Am. Electrochem. Soc., Trans. 45. pp. 297–309; Disc., 309–310, 1924.)—

The presence of oxygen or of comparatively highly ionised copper in solution is necessary to initiate selective corrosion. The acetate, lactate, bromate, and perchlorate of copper do not promote dezincification. Brass is not the only alloy susceptible to "dezincification"; copper-aluminium (70–30), manganese-copper (25–75), and cadmium-magnesium (85·7–14·3) undergo selective corrosion. From experimental evidence it is concluded that, excepting 90 %, or more, copper alloys, the commercial brasses will dezincify. Arsenic and nickel brasses should be further studied. [See Abstract 1026 (1924).] AUTHOR.

956. *Comparative Tensile Properties of Copper-Silicon-Aluminium and other Aluminium Alloys as Obtained on Separately Cast Specimens and Specimens Cut from a Crank-Case Casting.* **E. H. Dix, Jr., and A. J. Lyon.** (Inst. of Metals, J. 32. pp. 27–40, 1924.)

957. *Some Experiments on the Effect of Casting Temperature and Heat-Treatment on the Physical Properties of a High-Tin Bronze.* **F. W. Rowe.** (Inst. of Metals, J. 32. pp. 73–79; Disc., 79–80, 1924. Engineering, 118. pp. 430–432, Sept. 19, 1924.)

958. *Copper-Tin Equilibrium Diagram.* **T. Isihara.** (Tohoku Univ. Sci. Reports, 13. pp. 75–100, Oct., 1924. In English. Eighty-fourth Report from the Research Inst. for Iron, Steel, and other Metals.)—Contains the results of an investigation of the equilibrium diagram of the copper-tin system by the determination of the electric resistance of the alloys. The α constituent shows a progressive transformation beginning at 480° to 580° according to the concentration of tin. The maximum solubility of tin in α is 11 % at room temperature. The range of eutectoid transformation $\beta \rightleftarrows \delta + \alpha$ is 89 to 68 % copper. The eutectoid composition is 73 % copper and its temperature is 510°. Alloys containing 89 to 77 % Cu have an additional progressive transformation of α' to α at 580°. The γ constituent decomposes into eutectoid mixture of δ and η at 580°. The constituent δ is a compound Cu_4Sn. The fields β, $\beta + \gamma$, and γ are very different in form from those previously published. The peritectic line at 540° as found by Shepherd and Blough is not confirmed. The constituent η is a solid solution of tin in a compound Cu_3Sn. The eutectic at 225° terminates at 37 % copper, it contains 1 % copper. The progressive transformation ending at 180° is found in all alloys containing ϵ as a constituent. This transformation is similar to the A_2 transformation in iron. The constituent ϵ is a compound CuSn and has no capacity for dissolving η or tin below 400°. C. O. B.

959. *Relation between Elastic Tension and Magnetic Behaviour of Nickel Steels in the Neighbourhood of the Point of Transformation.* **W. del Regno.** (Accad. Lincei, Atti, 33. ii. pp. 87–91, Aug., 1924.)—The present paper gives the results of experiments with two of the reversible alloys, invar (36 % Ni) and a variety of platinite (44 % Ni), and with one of the irreversible alloys (22 % Ni). The results may be thus summarised. (1) In the case of the reversible alloys the change in the direction of the limit tension curve corresponds to a definite temperature, just as the alloy passes at a definite temperature from the ferromagnetic to the paramagnetic state. (2) In the case of the irreversible 22 % alloy the passage takes place very slowly through an interval of temperature which, from the point of view of magnetic behaviour, is characterised by the peculiar fact that in that interval the alloy may be in the ferromagnetic or the paramagnetic state according to whether this temperature be approached from a lower or a higher point. (3) For both types of alloys the temperature at which the limit tension curve changes its direction corresponds to that of nickel. (4) The analogy between elastic and magnetic behaviour revealed in nickel is evident in the three alloys. There remains to be established the behaviour of the other alloys, whether of low or of high nickel percentage, especially those in the neighbourhood of 80 % Ni, which, as is evident from recent researches on magnetic character, constitutes another zone of peculiar properties. [See Abstract 608 (1923).] E. F.

960. *Cast Alloys of Aluminium Containing Small Amounts of Magnesium.* **S. Daniels.** (Indust. and Engin. Chem. 16. pp. 1243–1249, Dec., 1924.)—The aluminium alloys containing magnesium are reviewed, and it is shown that with the exception of lynite and duralumin, magnesium alloys of the binary type are not important commercially. Magnesium is usually added in amounts less than 2 % ; its effect in these alloys is to increase the hardness, but at the expense of ductility. An equilibrium diagram curve for aluminium-magnesium alloys is given, together with hardness, elongation, and tensile strength test results. An account is also given of the method of preparation and examination of metallographic specimens. The physical properties of cast, and cast and heat-treated alloys are considered. The presence and effect of impurities, chiefly of iron and silicon, is also discussed. It is concluded that heat treatment of magnesium-aluminium alloys is not economically justifiable. The metallography of several alloys is described. A. W. J.

961. *Structure of Metals under Test.* **M. Polányi** and **E. Schmid.** (Zeits. techn. Physik, 5. 12. pp. 580–589, 1924. Paper read before the Deut. Naturforscher. u. Ärzte, Innsbrück, 1924.)—From tests on a specimen piece consisting of a single crystal and involving elongation, shear, etc., it is attempted to pass by the bridge of a test piece consisting of two crystals to the case of a polycrystal piece and explain its behaviour. The paper is illustrated by a dozen diagrams and photographs. E. H. B.

962. *Electro-Chemical Oxidation of Aromatic Hydrocarbons.* **F. Fichter.** (Am. Electrochem. Soc., Trans. 45. pp. 107–127 ; Disc., 127–130, 1924.)—Anodic oxygen is probably the most energetic of all oxidising agents. Various methods are studied for controlling the oxidation of organic bodies at the anode. Various electrolytes, carriers, and the effect of different anodes and different current-densities are discussed. Many new results are given and new views suggested. A. D.

963. *Heats of Oxidation.* **J. E. Moose** and **S. W. Parr.** (Am. Chem. Soc., J. 46. pp. 2656–2661, Dec., 1924.)—Heats are re-determined for *pure* Al, Be, Ce, Cd, La, Mg, Mo, Ta, Sn, W, and Zn by the direct method, and checked by weighing the oxide formed on combustion in oxygen. A. D.

964. *Peroxides and Peracids in Electro-Chemical Oxidation of Organic Compounds.* **F. Fichter.** (Am. Electrochem. Soc., Trans. 45. pp. 131–154 ; Disc., 154–159, 1924.)—Kolbe's hydrocarbon synthesis appears to be primarily an oxidation reaction. Numerous Kolbe reactions are discussed in detail. In many cases platinum anodes at high current-densities are essential to bring about the reaction. The oxidation potential of elemental fluorine is equal to or greater than that of nascent oxygen.

The peroxide-formation hypothesis has many advantages over other hypotheses. A. D.

965. *Twenty-Five Years' Progress in Explosives.* **C. L. Reese.** (Frank. Inst., J. 198. pp. 745–768, Dec., 1924.)

966. *Mobility of Ions in Solid Cuprous Sulphide.* **H. Braune** and **O. Kahn.** (Zeits. phys. Chem. 112. pp. 270–276, Sept. 20, 1924.)—Measurements of the coefficient of diffusion of silver ions in solid cuprous sulphide containing a little silver sulphide at various temperatures between 223° and 919° indicate that the silver ion possesses very considerable mobility, the values obtained for the coefficient being expressed by the equation,

$$D = 113e^{-2285/T}$$

On the other hand, cuprous sulphide containing a small addition of cuprous selenide shows at 230° no appreciable diffusion of selenium ions. T. H. P.

967. *Heat of Combustion of Standard Substances.* **W. Jaeger** and **H. v. Steinwehr.** (Zeits. phys. Chem. 114. pp. 59–64, Dec. 13, 1924. From the Reichsanstalt.)—Dickinson's value (26,442 Joules per gram) for the heat of combustion of benzoic acid, which was accepted by the 1922 Commission for fixing thermo-chemical standards, is questioned. The higher value obtained by the authors was rejected by the Commission, who considered that too high a value had been assigned to the water equivalent of the calorimeter. The authors state that their electrical method, using Pt thermometers, gives a higher degree of accuracy than other methods in which the water equivalent is calculated by assuming values for the specific heat of metals forming the component parts of the calorimeter. Further, their method gives a value, at once, in the units desired. It is suggested that differences in the samples used and in the methods of combustion may account for some of the differences in the results obtained. R. S. R.

968. *Electrometric Study of Hydrolysis.* **P. Job.** (Comptes Rendus, 179. pp. 1317–1319, Dec. 8, 1924.)—The hydrolysis of electrolytes may be investigated by adding to the solution a strong acid or base and determining electrometrically the displacement thus effected in the hydrolytic equilibrium [see Abstract 2854 (1924)]. For quantitative results to be obtained, the reactions must be carried out in an atmosphere free from carbon dioxide. For the solution of an alkali acetate of concentration A low enough for virtually complete dissociation, the concentration B of the hydrochloric acid added is given by :

$$B = C_H\left(1 + \frac{AC_H}{K + C_H}\right)$$

where C_H is the hydrogen-ion concentration and K the dissociation constant of acetic acid. Experiments made on these lines give the value $3\cdot5 \times 10^{-5}$ for the dissociation constant of acetic acid at 16° and $2\cdot6 \times 10^{-10}$ for the hydrolytic constant of acetates ; an explanation is suggested for the divergence of these figures from those usually accepted. For ammonia the dissociation constant is found to be $2\cdot8 \times 10^{-5}$, the hydrolytic constant of ammonium salts being $3\cdot2 \times 10^{-10}$. T. H. P.

969. *Hydrolysis Constant of Sugar.* **H. Colin and (Miss) A. Chaudun.** (Comptes Rendus, 179. pp. 1607–1609, Dec. 29, 1924.)—The velocity of inversion of sugar was believed to obey the law of mass action, and to be independent of the concentration of the sugar. Measurements showed that the velocity of hydrolysis increases more rapidly than the concentration of the sugar, and depends upon the catalyst employed, the velocity constant being greatest for HCl and nil for acetic acid. F. J. B.

970. *Heterogeneous Catalysis.* **W. E. Garner.** (Nature, 114. p. 932, Dec. 27, 1924.)—When oxygen is admitted to an active carbon surface [see Abstract 454 (1925)], heat is liberated owing partly to the formation of carbon monoxide and dioxide and partly to the formation of an adsorption complex, C_xO_y. By allowing for the heats of formation of the two gases, it is possible to obtain a value for the " heat of formation " of this complex, this including any decrease in energy of the surface owing to the liberation of the gases. The values of the heat of formation thus deduced are of the same order as the energy liberated in the formation of the C—C linking, as deduced from the heat of sublimation of carbon. Thus the valency of the surface carbon atoms is very far from being saturated by neighbouring carbon atoms. The ratio of the oxygen atoms adsorbed to those giving rise to carbon monoxide and dioxide decreases with rise of temperature, a proportion of the atoms adsorbed at the lower temperature being liberated as gases at the higher temperature. The high heats of adsorption are, indeed, due not solely to the energy liberated on combination of the oxygen atoms with the surface, but also to that liberated on the removal of the exposed carbon atoms, *i.e.*, carbon atoms with a high energy content, from the surface. Both energies are undoubtedly very high compared with the heat of formation of carbon monoxide, but their relative importance cannot yet be judged; the most active atoms are, however, removed on the first admission of oxygen. The increasing effectiveness of a surface with use may be due to absorption by the surface of part of the heat liberated during the heterogeneous reaction, with resultant increase, not only in the total surface but in the proportion of exposed atoms on the surface, *i.e.* an increased free energy of surface per sq. cm. T. H. P.

971. *Volta-Effect between Metal and Electrolyte.* **J. Guyot.** (Ann. de Physique, 2. pp. 506–638, Nov.–Dec., 1924.)—Presents the results of researches on the laws governing the potential difference between a metal and surrounding dilute electrolyte, when (1) the concentration and nature of the electrolyte and the metal used are varied; (2) small quantities of different organic insoluble substances are deposited in a thin layer on the surface of the liquid. The different possible methods of measurement are discussed, and finally an ionisation method which was employed is presented in detail. An air condenser is formed of the free surface of the liquid and a gilt plate suspended above it. The air-gap is ionised by α-rays from a polonium source, and the potential difference is found by balancing with an opposed field. The effect is independent of the nature of the electrolyte if equimolecular solutions are used, and increases with concentration if the electrode gives positive ions to the electrolyte, and *vice versa*. A thin film of organic substance diminishes the effect; this diminution commences immediately any of the " impurity " touches the surface, and increases up to a limit, dependent on the nature of the impurity. The limit occurs when a monomolecular film has been exceeded. This effect is attributed to an electrical polarisation of the molecules. A. C. M.

972. *A Property of very Small Bubbles of Gas in Water.* **H. A. McTaggart.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 129–131, 1924.)—The paper describes a method for the observation of small air bubbles in gas-free water and suggests a possible mode of attack for problems regarding the origin of the electric charge on the surface of small bubbles of air in water and on liquid surfaces in general. [Abstract 114 (1923)] records that the author found that a bubble of air could be made to change its sign merely by diminishing its size. The experiments now described show that if small oil bubbles are introduced on to the surface of the air bubbles, they exhibit a mutual repulsion for each other and push each other off the air bubble in a way that cannot be attributed to the Brownian movements. The microscope arrangement is detailed and a record of experimental procedure given. S. G. B.

973. *Electrolytic Preparation of Ozone.* **G. Malquori.** (Accad. Lincei, Atti, 33. ii. pp. 102–106, Aug., 1924.)—Archibald and Wartenberg showed [Abstract 1631 (1911)] that the superposition of a small alternating to the direct current increased the quantity of ozone obtained by the electrolytic method. In the present article the author furnishes the results of his experiments chiefly directed to ascertain the most favourable conditions as regards the concentration and nature of the electrolyte, the density of the d.c. and the ratio of the direct to the alternating current. The anode was a platinum pipe cooled by a water flow. The frequency of the alternating current was of 50 periods per second. The most favourable conditions were found to be: (*a*) solution of H_2SO_4, density comprised between 1·1 and 1·4; (*b*) density of the d.c., 10 amps./cm.^{2}; (*c*) intensity of the a.c., 3 amps. Lead anodes covered with lead dioxide also give good results for a certain ratio of the direct to the alternating current. E. B.

974. *An Attempt to Electroplate Tungsten on Iron.* **C. A. Mann** and **H. O. Halvorsen.** (Am. Electrochem. Soc., Trans. 45. pp. 493–508; Disc., 508–510, 1924.)—Salts of tungsten in which the metal occurs as anion are desirable for electrolysis. Such a salt can be supplied to a cell by electrolytic corrosion of a tungsten anode. This was accomplished by using both aqueous and non-aqueous electrolytes containing hydrogen chloride or alkali chlorides, but on electrolysis only an oxide of tungsten was obtained on the kathode. In some cases the resistance of the cell was too high to conduct sufficient current. A fused bath of lithium chloride gave proper conductivity, the tungsten anode corroded to form tungsten chloride, and a deposit of metallic tungsten was obtained on the iron kathode. AUTHORS.

975. *Acidity of Cobalt and Nickel Plating Baths. Use of the Oxygen Electrode.* **G. H. Montillon** and **N. S. Cassel.** (Am. Electrochem. Soc., Trans. 45. pp. 259–268; Disc., 268–272, 1924.)—A possible explanation is given for the failure of the hydrogen electrode in the direct measurement of hydrogen ion concentration of nickel and cobalt plating baths. The oxygen electrode gives approximate hydrogen ion concentration values, which are useful for controlling acidity in these solutions. For the plating baths used a *p*H of 6 gave the best current efficiencies and the most desirable plates. Further work is needed to establish the accuracy of this method. AUTHORS.

976. *The Electrolytic Production of Cobalt and Nickel Triacetates from the Diacetates; the Electrolytic Oxidation of Cobalt and Nickel Dichlorides.* **C. Schall** and **H. Markgraf.** (Am Electrochem. Soc., Trans. 45. pp. 161–171; Disc., 172, 1924.)—Pure cobalt and nickel diacetates were dissolved in absolute acetic acid. The solution was electrolysed between platinum electrodes, and pure well-crystallised nickel and cobalt triacetates were obtained. These electrolytic oxidation results support the freezing-point lowering determinations and direct chemical analysis, and indicate that the two triacetates have the simple formula $Ni(CH_3COO)_3$ and $Co(CH_3COO)_3$, respectively. Failure in obtaining these triacetates in the past has been found to be due to the presence of small amounts of water in the acetic acid solutions. Nickel and cobalt trichloride were obtained by electrolysing the dichloride, dissolved in concentrated hydrochloric acid, in a two-compartment cell. Evidence for the probable existence of higher chlorides, such as $CoCl_4$, is presented. AUTHORS.

977. *Hydration of Ions.* **A. Gyemant.** (Zeits. f. Physik, 30. 4–5. pp. 240–252, 1924.)—The hydration of ions is investigated from the standpoint of the molecular kinetic theory of electrical polarisation. An expression is deduced for the heat of hydration depending on the radius of the ions. The paper is not suitable for a short abstract. F. J. B.

978. *Greenawalt Electrolytic Copper-Extraction Process.* **W. E. Greenawalt.** (Am. Inst. Mining Eng., Trans. 70. pp. 529–567; Disc., 567–580, 1924.)—An account is given of the principal features and output and cost performances of various large typical electrolytic copper-extraction installations already in operation, particularly in relation to the grades of ore or concentrate which are or can be treated. The fundamental basis of the Greenawalt process consists in overcoming the deleterious effects of ferric Fe in the electrolyte, by reduction to ferrous Fe prior to electrolysis, in the course of a suitable combination of existing methods. SO_2, obtained by roasting CuS, is used as the reducer in the earlier stages of the treatment, being replaced by precipitated CuS as acidity increases above prescribed limits. The H_2S required for the precipitation of CuS may be generated from low-grade matte or other cheap, easily decomposed sulphide by treatment with denuded waste acid. The range of applicability of the process is thus widened to include sulphides, oxides, concentrates, the direct ore, and low-grade matte. The process is self-sustaining in acid on sulphide ores, and on high-grade oxidised ores. The deposition of about 1·0 lb. of Cu (a.c.), or about 1·4 lb. (d.c.), per kw.-hr. is attainable with the simultaneous regeneration of 3·0 lb. of acid, which is used cyclically in the process, it being claimed that, in this respect, the process affords a 50 % advance, according to published accounts, on other processes now in operation. The entire process can be made practically automatic and can be operated mechanically. Metallurgically it is independent of the magnitude of the unit. Explanatory diagrams and details of test demonstrations are given, and it is noted that the end product is all in a form directly saleable to the consumer. The possible applications of electrolytic methods to the treatment of ores containing precious metals, involving chloride solution electrolytes and Cu_2Cl_2 as reducer are briefly discussed. A. B. C. L.

979. *Corrosion of Brass as Affected by Grain Size.* **R. J. Anderson** and **G. M. Enos.** (Am. Inst. Mining Eng., Trans. 70. pp. 391–401; Disc., 401–403, 1924.)—The results are given of experiments on the accelerated electrolytic corrosion of sheets and tubes of Admiralty metal (70 copper, 29 zinc, 1 tin) annealed in various ways so as to produce differences in the size of grain. A current sufficient to give a current-density of not more than 0·2 amp. per sq. dm. was used, the electrolytes being as follows: (1) Acid mine water containing 2020 parts per million of free sulphuric acid, together with iron and aluminium sulphates; (2) aqueous solution containing 15,760 parts per million of sulphuric acid; (3) sea water (4 % of salt); (4) 8 % sodium chloride solution; (5) 1 % sodium hydroxide solution and (6) tap water containing 8 parts per million of calcium carbonate. It is found that the effect of variation of the size of the grain within the limits 0·01 and 0·1 mm. diameter is very small, although in general brass with small grain corrodes less than that with larger grain. The microstructural appearances of the material corroded in liquids having reactions of the same kind are similar. T. H. P.

980. *Conductivity of Nickel Depositing Solutions.* **L. D. Hammond.** (Am. Electrochem. Soc., Trans. 45. pp. 219–226; Disc., 226–227, 1924.)—The conductivity of solutions of nickel sulphate of various concentrations was measured, and the effect upon the conductivity of common additions to nickel plating baths was determined. Ammonium chloride was found to have the greatest relative effect in decreasing the resistivity, and a beneficial action on the formation of good deposits. AUTHOR.

981. *The Electrolytic Preparation of Salicylic Aldehyde from Salicylic Acid.* **K. S. Tesh** and **A. Lowy.** (Am. Electrochem. Soc., Trans. 45. pp. 37–45; Disc., 45–48, 1924.)—Salicylic aldehyde is prepared electrolytically by the reduction of salicylic acid (sodium salt) to the aldehyde. The ordinary type of diaphragm cell is used with a mercury kathode, using boric acid and sodium sulphate as catholyte. A current-density of 6 amp. per sq. dm. is used, and the temperature is kept between 15° and 18° by means of a freezing mixture. The aldehyde is fixed as soon as formed by means of sodium bisulphite, and is recovered by means of acid hydrolysis and steam distillation. Up to the present stage of the process the best yield obtainable is 55 per cent. AUTHORS.

982. *Commutator Measurements on Polarised Electrodes.* **M. Knobel.** (Am. Chem. Soc., J. 46. pp. 2613–2621, Dec., 1924.)—In the usual commutator method of measuring overvoltage one segment of the commutator connects the polarising current for a definite time interval and after breaking the current another segment connects the potentiometer for an equal time. Unless the overvoltage be constant after disconnecting the electrolysing current the potentiometer must, of necessity, be measuring an average of the potential and give a value without any meaning. By a specially designed commutator, curves of overvoltage against time, both for increasing and decreasing overvoltage, have been obtained and the results confirm that the usual commutator method of measuring overvoltage is incorrect for all overvoltages because of the extremely rapid drop in overvoltage when the electrolysing current is disconnected. By a graphical treatment of the data, approximate values for the gas concentrations on the polarised electrodes have been obtained. It appears that on smooth electrodes the adsorbed H_2 is present as about 0·01 of a molecular layer at low polarisations, approaching a molecular layer at high polarisations. R. S. R.

983. *Polarisation Capacity and Electrical Double Layers.* **A. L. Clark.** (Roy. Soc. Canada, Trans. 18. Sect. 3. pp. 275–292, 1924.)—The earlier work is reviewed and the polarisation capacities of mercury, platinum, platinum black, gold, tungsten, lead, and carbon were determined. The apparatus consisted of a large electrode of the given substance immersed in an electrolyte contained in a crystallising dish. The other electrode consisted of a small piece of the same material. The measurements of capacity were made by photographing the oscillations. The variations of capacity with concentration of the electrolyte (sulphuric acid) and with the distance between the electrodes were determined. The oscillatory charge and discharge was also investigated. F. J. B.

984. *Isoelectrical Points.* **R. Kuhn.** (Zeits. phys. Chem. 114. pp. 44–48, Dec. 13, 1924.)—The isoelectrical point of an amphoteric electrolyte is the hydrogen ion concentration at which the concentrations of the kathion and anion and the undissociated molecules of the amphoteric electrolyte are all equal. The paper deals with the theory of isoelectrical points and attempts to explain the differences found between different methods for measuring hydrogen ion concentrations. F. J. B.

985. *Electrolysis of Mixtures of Acetates and Trichloracetates.* **R. E. Gibson.** (Roy. Soc. Edinburgh, Proc. 44. 2. pp. 140–152, 1923–1924.)—Previous experiments on the electrolysis in aqueous solution of mixtures containing the salts of organic acids permitted of division into three classes. Potassium acetate and potassium trichloracetate although of the same type behave differently, when electrolysed singly. When they are electrolysed together mixed compounds are formed but only to a very slight extent. A small amount of trichlormethyl acetate is to be found among the reaction products and hexachlormethane and methyl chloride are also produced during the electrolysis of the mixture. No methyl alcohol appears among the final products, but formaldehyde occurs in considerable quantities. This oxidation is connected with the production of an oxidising agent such as chlorine at the anode. The presence of either of the original salts affects the other by decreasing the yields of the normal products and by promoting the production of substances like trichlormethyl alcohol and ethylene which result from the oxidation of a single molecule of the acid. An explanation of the phenomena is given. R. S. R.

986. *Progress in Electrolytic Iron.* **D. Belcher.** (Am. Electrochem. Soc., Trans. 45. pp. 455–470; Disc., 470–474, 1924.)—The author sums up the progress made in the electrodeposition of iron in the last seventy-five years. A brief description of the two plants now in commercial operation is given, and a short account of the development work on the Milford process for the hydrometallurgy of iron ores is added. AUTHOR.